CHAPTER

Convertible Arbitrage: An Overview

There was a time when the word "arbitrage" brought to mind a picture of a mysterious realm in finance which few people seemed to be inclined or at least to have the knowledge to discuss. I knew in a general way that profits depended upon price differences, but I believed that it was with lightning speed at a nerve-racking pace that computations, purchases, and sales must be executed in order to reap a profit.

-Meyer H. Weinstein, Arbitrage in Securities

CONVERTIBLE ARBITRAGE: A BRIEF HISTORY

The practice of convertible arbitrage includes the traditional purchase of a convertible while shorting its underlying stock, but also includes warrant hedging, reverse hedging, capital structure arbitrage, and various other techniques that exploit the unique nature of the global convertible and warrant marketplace. While the quantitative modeling, arcane mathematics, and hedge fund strategies affiliated with such techniques may make the practice seem a symbol of the latest in financial innovation, it has actually been around for more than a century, practically since the launch of convertible securities. Convertible securities came into being as a way to make securities more attractive to investors. Convertible bonds are not new; issuers and investors have been using them since the 1800s. During the nineteenth century, the United States was what we would now classify as an emerging market. It was not easy to gain access to capital in a rapidly growing country. The convertible clause was added first to mortgage bonds to entice investors to finance the building of the railroads. The Chicago, Milwaukee & St. Paul Railway, for example, used many convertible issues for financing between 1860 and 1880. In 1896, that company had 12 separate convertible issues outstanding, most bearing a 7 percent coupon.

Convertible securities are relatively simple in concept: A convertible bond is a regular corporate bond that has the added feature of being converted into a fixed number of shares of common stock. Conversion terms and conditions are defined by the issuing corporation at issuance. (A convertible security may also be preferred stock, but convertibles are best understood by studying convertible bonds.) The actual terms can vary significantly, but the traditional convertible bond pays a fixed interest rate and has a fixed maturity date. The issuing company guarantees to pay the specified coupon interest, usually semiannually, and the par value, usually \$1,000 per bond, upon maturity. Like other nonconvertible bonds, a corporation's failure to pay interest or principal when due results in the first step toward company bankruptcy. Therefore, convertible bonds share with nonconvertible bonds the feature that bond investors consider most precious: principal protection. Convertibles are senior to common stock but may be junior to other longterm debt instruments. Convertibles have one important feature that other corporate bonds do not have: At the holder's option, the bond can be exchanged for the underlying common stock of the company. This feature completely changes the investment characteristics of the bond, and is one of the characteristics that make convertible arbitrage possible.

Meyer Weinstein's 1931 book, cited above, notes that with the advent of rights, warrant options, and convertible securities that began during the 1860s railroad consolidation, arbitrage in equivalent securities was born. By the 1920s, the practices and techniques established became the focus of Weinstein's book; while rudimentary, they were effective. Most of the convertible, warrant, and rights arbitrage positions depicted in the book either offered discounts to parity at conversion, or were passive hedges without mathematical precision. Although lacking the exactitude required today, these hedges were driven by the same premise: to successfully exploit the non-linear relationship of the convertible with respect to the underlying stock:

If the price of the stock and the convertible security of a company are not rising and falling together, there is an opportunity for the arbitrageur to take a long position in the convertible security, and a short position in the stock into which the convertible security is convertible. When the convertible security is selling at a price close to its investment value, and the price of the stock into which it is convertible is not at a great discount, the arbitrageur may buy the convertible security and sell one-half of the stock short, leaving himself in a position of being theoretically long and short at the same time. In this form of arbitrage he is hedged against either a rise or

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a fall of the stock, and any rise in the convertible security will be a profit. (Weinstein, *Arbitrage in Securities*, p. 151)

Weinstein is describing a classic convertible "market-neutral" hedge, still a cornerstone of contemporary convertible arbitrage practices. Without the benefit of option pricing models or financial calculators, however, the early years of arbitrage resembled more art than science. The author does not attempt to quantify investment values (fixed income components), and most hedging is based on shorting simply "one-quarter," "one-half," or "three-quarters" of the stock against the long convertible position. Since the same limits of precision applied to the whole marketplace, presumably greater inefficiencies still left room for successful arbitrage. Despite the simpler nature of the hedging described in this book written more than 70 years ago, it remains remarkably relevant to convertible arbitrage practiced today. The book ventured into some of the pitfalls and basic necessities, including margin, short interest rebates, trading, merger arbitrage, and even international securities arbitrage.

In 1967, Edward O. Thorp's and Sheen T. Kassouf's book, Beat the *Market*, became a must read for the convertible and warrant arbitrage community. This may be the first book that approached the convertible arbitrage market in a mathematical format. (Thorp had already made a name for himself as a master of quantitative systems a few years earlier, when his bestselling book, Beat the Dealer, introduced card counting to players of Black Jack.) The authors advanced the concept of breaking down convertibles into two components, bond and warrant, and quantifying each separately in order to identify hedging opportunities. Using their approach, they sought to identify a convertible when priced close to its value strictly as a fixed-income instrument (its investment value), while also selling close to its equity value (conversion value). Issues with these attributes tend to be undervalued and offer good downside protection (being priced close to their bond "floor"), along with a high degree of upside participation should the stock price rally. Not content with the returns of a market-neutral strategy, Thorp and Kassouf also looked for the opposite hedge opportunity by identifying overpriced issues and applying a ratio hedge (a strategy to be discussed in Chapter 9). The authors' portrayals of their successes in ratio and reverse hedging thus promoted using mathematical formats well beyond Weinstein's less precise market neutral hedges, and signaled the beginnings of the complex quantitative modeling techniques that make up the toolbox of the modern convertible arbitrageur.

John Calamos' book, *Convertible Securities*, 1985, was the first complete book on convertibles and included option price theory applied to convertible valuation as well as many convertible hedging techniques.

Moving from the conceptual breakthrough of separately valuing a convertible's bond and option components to the current state of convertible

CONVERTIBLE ARBITRAGE

arbitrage, the range of opportunities is clearly wider than at any time in the past, due largely to the rapid growth in the global convertible market, augmented by improvements in technology, financial models, innovative derivative products, and global information flows. With this unprecedented breadth in the opportunity set comes unprecedented complexity, competition, and even new kinds of risks. During this same period, hedge funds have both benefited from and contributed to the growth of convertible arbitrage: As the benefits of the asset class have become more apparent to issuers and to investors, issuance and liquidity have grown exponentially, with hedge funds providing a large role in demand. Typically, most investors who gain access to the convertible arbitrage arena do so through hedge funds.

Although A.W. Jones founded the first hedge fund in 1949, the concept remained virtually unknown until 1966, when *Fortune* magazine highlighted Jones's investment feats. The hedge fund "industry" sprouted up in the next few years as a number of investors (including Warren Buffett) delved into hedging techniques. (The timing of this first wave of hedge funds corresponds with the publication of *Beat the Market*, and is another example of the emergence of quantitative analysis, which began its dramatic, ongoing influence on the investment community.) During the 1970s, the macro investment hedge funds popularized by George Soros made large bets regarding currency, bond, equity, and commodity markets across the globe. These funds were not necessarily hedged nor were they considered market neutral. The bull market of the 1980s and 1990s helped fuel the hedge fund industry's growth as investors looked for even better returns or non-correlated return profiles.

The 1990s produced the hedge fund industry's greatest growth, as it moved from the margins to the mainstream, at least among high-net-worth circles. The globalization of the marketplace, combined with the tremendous wealth creation and technological progress during that decade, all fed the growth of the hedge fund industry. The hedge fund industry today includes funds that specialize in one hedge strategy as well as funds of funds that include a full spectrum of hedge fund strategies. According to Hedge Fund Research Inc., the hedge fund universe was estimated to include less than 200 funds with approximately \$20 billion in assets in 1990; by 2000, over 4,500 funds existed with nearly \$500 billion in assets—not including leverage. The assets employed in convertible arbitrage strategies have also grown dramatically. According to Tremont Advisors, assets in convertible arbitrage have increased 25-fold over the past nine years. See Figure 1.1.

The hedge fund universe can be roughly divided into two camps: directional strategies that participate in market movements, and non-directional strategies, whose returns are for the most part unaffected by broad market moves. Convertible arbitrage is placed in this second group, along with

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Tremont Advisers, Inc.

555 Theodore Fremd Ave. Rye, New York 10580 T 914 925 1140

Total Asset History

December 1994 - December 2002

I C	dollare	in	mil	lione	
υ.υ.	uullais		11111	10112	

	Dec-94	Dec-95	Dec-96	Dec-97	Dec-98	Dec-99	Dec-00	Dec-01	Dec-02
Total assets	\$798	\$1,232	\$2,727	\$5,276	\$6,861	\$8,486	\$11,912	\$20,725	\$25,647
Asset flows	\$14	\$240	\$1,188	\$1,952	\$1,268	\$307	\$1,698	\$7,100	\$3,150
% change	0.0%	1614.3%	395.0%	64.3%	-35.0%	-75.8%	453.1%	318.1%	-55.6%

Convertible Arbitrage Market Value



Source: Tremont Advisers, Inc, used with permission.

FIGURE 1.1 Convertible Arbitrage Market Value.

other arbitrage practices that tend to gain more investor attention during sideways or declining markets. For example, during the corporate-scandalridden second quarter of 2002, more than half of all new hedge fund inflows went to either equity or convertible arbitrage strategies, according to Tremont Advisors Research. The following list contains the various hedge fund strategies common in the hedge fund universe, divided according to directional and non-directional strategies.

Directional Strategies

- 1. Global macro—invests in global markets emphasizing macroeconomic changes.
- 2. Equity (non-hedged)—long only equity with manager's specialty focus including value stocks, growth stocks, or sector/industry.
- 3. Short only—short sells equity for companies that are overvalued.
- 4. Emerging market—invest in global emerging market countries' debt and/or equity securities.
- Distressed security—invest in companies that are bankrupt or undergoing reorganization.

Non-Directional Strategies

- 6. Convertible arbitrage—purchases long convertible securities and shorts the underlying stock with very low equity exposure.
- 7. Merger arbitrage—generally invests long in the stocks of companies that are being acquired while shorting the stock of the acquiring company.
- Equity market neutral—long equity and short equity with total net exposure of near zero.
- 9. Fixed-income arbitrage—includes arbitrage in fixed-income securities, including corporate bonds, government bonds, mortgage-backed bonds, futures, and options. The hedging includes yield curve arbitrage, relative value trades, and swaps.
- Relative value arbitrage—arbitrage in related securities that temporarily diverge from their expected value or relationship.

WHY HEDGE WITH CONVERTIBLES?

Convertible securities are hybrid issues that have fixed-income and equity characteristics. Convertible arbitrage is popular because of the relatively predictable hedge that can be established between the underlying common stock and the convertible. Convertible arbitrage is often considered a relativevalue strategy because convertible arbitrage funds often establish a marketneutral profile with very little correlation to the equity markets. The profit potential is largely a function of relative price inefficiencies between the convertible and common stock along with the series of cash flows derived from the hedge. However, many other techniques are employed that not only rely on the predictability of the relationship between the convertible and its underlying stock but also exploit the convexity of the security as well as the arbitrageur's other expertise. In fact, convertible hedging should be considered a relative-value strategy on the downside because the hedge is less precise



and the price inefficiencies are greater, but the value of the short stock and long convertible positions are dependent on each other to varying degrees. While on the upside (when the convertible price is greater than 120 percent of par), the strategy should be considered convergence hedging because of the clear convergence of the convertible and underlying stock.

CONVERTIBLE ARBITRAGE PERFORMANCE

As shown in the list above, the success and dramatic growth in hedge funds over the past decade have been mirrored in the convertible-hedge fund field, and many hedge funds utilize convertible arbitrage techniques. The popularity of convertible arbitrage is attributable to its high risk-adjusted returns with a low degree of equity risk and low correlation to both equity and bond markets.

The performance histories of three well-known convertible arbitrage indexes, each of which includes various managers employing various degrees of leverage and hedging techniques, illustrate the benefits of the strategy. See Table 1.1. The indexes (HFR, CSFB/Tremont, and Hennessee) demonstrate a much lower volatility level (3.5 percent-5.2 percent annual standard deviation) than the global equity index MSCI World (14.1 percent) or the S&P 500 (13.7 percent). More importantly, the Sharpe ratio indicates a much better risk-reward trade-off than the equity markets: HFR's index posts a Sharpe ratio of 1.96, while the Hennessee index comes in at 1.36. Both of these compare very favorably to the 0.48 Sharpe ratios for the MSCI World index, and the 0.97 for the S&P 500. Furthermore, the convertible arbitrage indexes showed more consistent returns with a smoother wealth-creating process. The equity markets posted negative returns in 32 percent to 36 percent of the months over the 124-month period, while the convertible arbitrage indexes posted negative returns in only 13 percent to 18 percent of the months.

The convertible arbitrage indexes show remarkably low equity sensitivity (Beta) and equity correlations. See Table 1.2. The betas compared to the MSCI World index are only in the range of 0.04 to 0.09, meaning that only 4 percent to 9 percent of the volatility in returns of the hedge indexes can be explained by the changes in the world equity markets. The return distribution has a slight negative skew and the positive kurtosis indicates that the distribution also demonstrates a high degree of peakedness relative to a normal distribution and therefore a tighter distribution of returns is present. The low beta and correlation indicate that the source of returns in convertible arbitrage investing is not a function of taking equity market risks. Obviously, the positive alphas generated by the convertible arbitrage indexes are desirable,

	# of	Annual	Volatility		Worst 1-Month		Worst 1-Year
	Monthly Returns	Returns (%)	Annual (%)	Sharpe Ratio	Return (%)	Negative Months	Return (%)
S&P 500 (total return)	124	18.3	13.7	76.0	-14.5	32	-3.1
MSCI World (total return)	124	11.7	14.1	0.48	-13.3	36	-16.5
MSCI Europe (total return)	124	13.5	14.7	0.58	-12.6	34	-12.1
HFRI Convertible Arbitrage Index	124	11.9	3.5	1.96	-3.2	13	-3.8
Hennessee HF Index-Convertible	88	10.1	3.7	1.36	-3.3	14	-7.1
Arbitrage							
CSFB/Tremont Convertible Arbitrage	76	9.3	5.2	0.83	-4.7	18	-9.0

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Convertible Arbitrage Risk and Return
TABLE 1.1

Source: HFR, Hennessee, CSFB/Tremont, Datastream, UBS Warburg calculations, period ending April 2000.

Index

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Convertibl
of (
Analysis
Statistical
TABLE 1.2

						Correlation
	Alpha to	Beta to			Correlation	JPM
	MSCI	MSCI		Excess	MSCI	Global
	World	World	Skew	Kurtosis	World	Bonds
HFRI Convertible Arbitrage Index	0.86	0.08	-1.52	3.54	0.330	-0.004
Hennessee HF Index—Convertible	0.68	0.09	-1.23	3.17	0.308	-0.058
Arbitrage						
CSFB/Tremont Convertible Arbitrage	0.71	0.06	-1.66	4.08	0.146	-0.252
EACM Relative-value Convertible Hedge	0.82	0.04	-1.56	4.46	0.183	-0.457
Conversion HEB Hannaccaa CCERMamont Evolut	ion Accor Date	V JBL moster	Vortan Sandarov	lations pariod a	ding Amil 2000	

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Source: HFR, Hennessee, CSFB/Tremont, Evaluation Assoc., Datastream, UBS Warburg calculations, period ending April 2000.





FIGURE 1.2 Capital Market Line (CML) and Potential Return Distributions.

but the low beta, low correlation to the debt and equity markets, along with the high Sharpe ratio makes the case very compelling. In fact, the returns are equity-like while the volatility levels are below that of the bond market. It is clear why convertible arbitrage has grown so dramatically in the past decade.

The Capital Market Line (CML) in Figure 1.2 indicates in yet another way the attractive risk-reward tradeoff produced by convertible hedge investing over the 1990s. The CML is used to demonstrate the risk premium assumed in the Capital Asset Pricing Model, or CAPM, and illustrates the expected rates of return of a particular investment based on its beta and in relation to the risk-free rate of return. Here, we see not only the dramatically lower risk than that of the equity market, but also that the annualized returns are well above the expected return implied by the risk premium. In fact, a full 85 percent of the range of distribution lies above the CML. Clearly, over the long term convertible arbitrage has offered an exceptional financial market investment opportunity.

Our experience at Calamos Investments, with convertible arbitrage can be seen in Figures 1.3 and 1.4. The low correlation with the stock and bond markets produces a significant reduction in overall portfolio risk—without sacrificing any return. In fact, this non-levered convertible arbitrage fund has produced returns that have beat the equity market since 1995 with nearly one-quarter of the volatility. The annual returns can also be seen with the



FIGURE 1.3 Growth of \$1.00: Calamos Market Neutral Fund Strategy versus the S&P 500 Index.



FIGURE 1.4 Distribution Comparison of Annual Calendar Returns: Calamos Market Neutral Fund Strategy versus the S&P 500 Index.

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CONVERTIBLE ARBITRAGE



FIGURE 1.5 Risk versus Reward.

bar chart once again indicating a consistent return profile. See Figure 1.4. The smoother wealth creation process created by blending convertible arbitrage into the asset mix moves investors into the coveted northwest quadrant of the risk-return spectrum. Another reason for the surge in convertible arbitrage in the hedge fund products can be seen by the positive shift in the efficient frontier that has occurred from including convertible arbitrage funds into the asset mix as demonstrated in Figure 1.5.

WHAT ABOUT RISKS?

Calling convertible arbitrage a "low-risk" strategy is calling it a low-volatility one, but it should not suggest that the strategy does not encounter *types of* risk; indeed, the strategy is immersed in risk. It could be said that convertible arbitrage is actually defined by how those risks are recognized, controlled, avoided, or exploited. Investment hedging is an attempt to avoid or lessen a financial risk or loss by making a counterbalancing investment. In practice, hedging techniques create a tradeoff between acceptable and unacceptable risks by managing or attempting to eliminate specific unacceptable



risks. The hedge or counterbalancing position often introduces a new, arguably controlled, risk to the position. Of course the objective would be to control the risks that are predictable or acceptable while retaining risks that are not significant or are very unlikely. In this respect, convertible arbitrage is no different than other hedging practices, as many types of risks and profit opportunities exist. Chapter 3 will further investigate the types of macro risk factors and the convertible arbitrageur's methods of controlling them, briefly listed here:

- 1. *Equity Market Risk*—Convertible arbitrageurs control equity volatility by shorting the underlying stock against the long convertible position, producing a very low beta risk and if properly hedged, a market neutral position.
- 2. *Interest Rate Risk*—Like all corporate bonds, prices of convertible bonds move inversely to interest rate changes. The degree of sensitivity to a change in rates varies, and is a function of how closely the issue trades in relation to the fixed income value of the security. The short stock position provides a degree of hedging against rising interest rates because such a change often precipitates declining stock prices. Also, unlike its fixed income value, a convertible's embedded option value instead moves in tandem with rate changes and provides some additional interest rate protection. In general, convertible arbitrageurs hedge interest rate swaps.
- 3. *Credit Risk*—Convertible arbitrage is exposed to credit risk through the long convertible position. To some extent, the short stock position will hedge a portion of the credit-spread risk because as spreads widen, stock prices generally decline. But to eliminate most of the credit-spread risk with a short stock position, the arbitrageur would need to short considerably more stock than a neutral hedge profile would call for, placing the position at considerable risk should spreads not widen and stock prices appreciate. Convertible arbitrageurs typically hedge credit-spread risk with the use of credit default swaps or by shorting a straight bond or another convertible bond from the same issuer against the long convertible position.
- 4. *Liquidity Risk*—Convertible arbitrage is subject to various liquidity risks, including the long convertible position not trading well and bid-ask spreads widening, the short stock borrow being called in, or a short squeeze occurring. Lower credit quality convertibles face additional liquidity risks if they fall out of favor during certain market environments. Also, liquidity risk can occur due simply to the size of an issue when issued by small companies or in small amounts. Since hedging liquidity risk is not possible, the arbitrageur must utilize the listed options market, eq-

uity market, and straight corporate market to provide additional protection against the difficult liquidation of a long, or the calling in of a short.

- 5. Legal Provision and Prospectus Risks—The prospectus provides many degrees of potential risks for issues such as early call, take-over protection, special dividends, last interest rate payment in the event of call, and so forth. Convertible arbitrageurs can best protect against these risks by being aware of the potential pitfalls and by adjusting the hedge or type of hedge to address any such risks.
- 6. *Currency Risks*—Convertible arbitrage opportunities often cross many borders, exposing positions to currency risks. In some convertible structures, multiple currency risks are present. Arbitrageurs generally employ currency futures or forward contracts to hedge this risk.
- 7. Leverage Risk—Financial leverage is one of the major macro risks that exist in the hedge world. Leverage magnifies returns—and mistakes. It is important to understand the degree of leverage employed in the convertible hedge marketplace as well as the entire hedge universe. Shocks to the system often cause a huge exodus out of a particular market or asset type, a situation made all the more severe if leverage is excessive. When short interest rates rise and increase the cost of carry for hedge funds, de-leveraging can have a disruptive market impact. Although arbitrageurs can avoid this problem by hedging against short interest rates, in general all of the above macro risks need to be further hedged if a highly levered market is disrupted.

Another important facet of the convertible market that attracts hedge funds is the ability to establish hedged positions that earn a levered yield while offsetting any equity risk in the underlying stock. In fact, the levered yield hedge profile—in certain interest rate environments with convertibles trading in the money—offers the nearly perfect hedge (this hedge, and the application of leverage in general, is explained further in Chapter 5).

Not all convertible arbitrageurs seek to master all of the above risk opportunities and pitfalls: Convertible-hedge funds will often establish positions that have a fundamental or credit bias as well as an interest-rate bias to take advantage of the skill set or expertise of the particular arbitrage firm, in effect determining which risks to isolate and exploit. Prospective investors should determine which of the macro risks a given hedge fund seeks to manage. Proper disclosure from the convertible arbitrage fund should provide some clarity regarding these macro risks and their approach to them. In addition to their awareness of these macro risk issues, arbitrageurs also analyze the more issue-specific "greek" risks (discussed in detail in Chapter 3) and portfolio level risks (discussed in Chapter 10).



BASICS OF CONVERTIBLE SECURITIES

A primer on convertible bonds may be necessary before jumping into some of the more complex valuation and hedging discussions. The concept promoted by Thorp and Kassouf back in 1967 still provides a foundation for such a primer: Convertible bonds can be thought of as fixed-income securities with an embedded equity option. See Figure 1.6. The convertible security has characteristics of both securities and as a result offers an asymmetrical risk and return profile.

The convertible feature allows a convertible holder to convert the bond into a predetermined number of shares of common stock (known as the conversion ratio, this number is set at a bond's issuance).

> Conversion Ratio = Par Value/Conversion Price Conversion Price = Par Value/Conversion Ratio

Like traditional fixed-income securities, the convertible bond has a par value and pays coupon interest (usually semiannually for U.S. issues and annually for European issues). Because the convertible bond offers a stream of cash flows and par value at maturity, it is also sensitive to changes in interest rates and credit-quality assessments, as are other fixed-income vehicles. The convertible bonds embedded option or warrant changes the nature of the security, though, making the convertible's price movements also sensitive to changes in the underlying equity value. Thus, this unique security is sensitive to both equity and fixed-income factors to varying degrees throughout the life of the security. The convertible's unique structure contributes to the non-linear relationship between it and its underlying security, making it especially suitable for hedging.

Figure 1.7 illustrates the convertible's structure and risk/reward tradeoff: The horizontal axis represents the underlying stock's price range for the convertible, while the vertical axis represents the convertible bond's price range. The horizontal line labeled investment value (*IV*) represents the fixed-



FIGURE 1.6 The Convertible Bond.



FIGURE 1.7 Convertible Structure and Risk-Reward Tradeoff.

income value of the convertible. The investment value is equal to the present value of the coupon interest payments plus the principal value discounted at the appropriate credit-adjusted rate, where:

$$IV = \sum_{t=1}^{n} CPN/(1+k)^{t} + par/(1+k)^{n}$$

CPN = coupon, par = par value, k = credit adjusted discount rate, n = number of periods to maturity, t = current time.

The fixed-income value (investment value) will rise or fall in accordance to changes in either interest rates or credit-quality ratings. Of course, the investment value approaches par value as maturity nears, so it increases in value each year, if all other factors were held constant.

Since each convertible can be converted into a predetermined number of shares of common stock, we can represent this equity value on the graph as a 45-degree line. As the stock price increases, the equity value (conversion value) of the convertible also increases. The investment value and the conversion value become minimum values for the convertible price and represent boundary conditions for convertible valuation. This occurs because if the value of the convertible breaches either of these boundaries, theoretically a risk-free arbitrage would exist with speculators quickly correcting such an inefficiency. In reality, slight discounts to conversion value do occur. Discounts to the investment value may also occur, but only rarely in the invest-

ment-grade universe. In the below-investment-grade convertible universe, where bond valuation is more a matter of supply and demand as well as an art form, many opportunities present themselves. But to maintain the simplicity of this discussion, the conversion value and the investment value represent hard boundary conditions. In fact, convertibles normally trade at a premium to these values because they represent the combination of these components. The investment value premium represents the amount that the convertible is trading above its investment value or fixed-income component expressed as a percentage. The higher the investment value premium, the more equity sensitive the issue.

Investment Value Premium = (Convertible Price – Investment Value) Investment Value

The premium above conversion value represents the percentage premium that the convertible is trading above its equity value component. The higher the conversion premium, the lower the equity sensitivity, and the lower the conversion premium, the more equity sensitive the issue. The conversion value is also known as parity value in the convertible marketplace.

Conversion Value Premium = $\frac{(\text{Convertible Price - Parity})}{\text{Parity}}$

Figure 1.7 also depicts the investment value, investment value premium, conversion value, and conversion premium, and finally the theoretical convertible price track. The convertible price track looks similar to a call option price track. The non-linearity of the price track presents convertible buyers and arbitrageurs with a unique risk/reward opportunity. The convertible theoretically has unlimited appreciation potential with limited downside risk.

To understand the basic convertible terms and premiums, let's start with a hypothetical convertible as seen in Figure 1.7. The convertible is a 5 percent coupon issued by XYZ Corporation with a 10-year maturity and each bond is convertible into 50 shares of stock with a conversion price of \$20. The current bond price is 100 percent of par and the stock is priced at \$16 per share. The issuing company has an existing straight corporate bond with equivalent seniority trading at 400 basis points over the 10-year treasury bond. Since each bond is convertible into 50 shares of stock, the conversion value of the bond is currently calculated by multiplying the 50 shares by the \$16 stock price for a conversion value of \$800 per bond. The conversion premium is the difference in percentage terms between the current bond price of \$1,000 and the current conversion value of \$800 or ${($1,000 - $800)}/{800} = .25$ or 25 percent premium. The investment value can be determined by discounting the present value of the coupon and principal payments (using the formula for investment value discussed at the beginning of this section) at the 400 basis points above the 10-year treasury that is currently yielding 4 percent to maturity. Therefore, discounting the 5 percent bond at 8 percent results in a investment value of \$799 per bond. The investment premium is the difference between the current bond price and the investment value or {(\$1,000 - \$799)/799} = 25.2 percent.

RISK-REWARD ANALYSIS

Convertibles make excellent hedge vehicles because of the certainty of convergence in value to parity as the stock price climbs as well as the convergence to fixed-income value as the stock price declines. But they also are an excellent hedge vehicle because of the convexity of the relationship between the stock price moves and the convertible price. This non-linear relationship is the gamma in the convertible that also explains the risk-reward ratio in the investment.

The risk-reward ratio can be determined by moving the stock price up and calculating the convertible's value and total return relative to the underlying stock and then doing the same with a downward stock price move. Chapters 1 and 2 discuss how the convertible's value can be determined. In our XYZ example, if the stock price moves up 20 percent over the next 12 months, the convertible is expected to move up 11 percent and with income the total return should be 16 percent for an upside capture of 16/20 or 80 percent. For a 20 percent stock price decline, the convertible is expected to decline 9 percent and with income be down only 4 percent for a downside capture of only 20 percent. This convertible offers a reward to risk ratio of 4 to 1. Hedging this type of convertible and capturing some of this gamma is explained later in Chapter 6.

METHODS OF VALUATION

Determining the "correct" price track for a convertible involves option pricing models with many variables and assumptions. Valuing the nontraditional convertible becomes even more complex and interesting, as we will discuss in Chapter 2. The Black-Scholes option-pricing model, however, can be used for pricing basic convertible structures. Combining a Black-Scholes model to value a convertible's embedded equity option with a basic bond valuation model offers investors a simple model for convertible valuation. The model needs to be adjusted, however, for factors such as dividendpaying stocks, probability-based call terms, adjusted strike prices (based on the fixed-income value and probability of call), dilution, and European style

exercises, to name a few. The basic Black-Scholes call option model determines the call value with the following equation:

Call option =
$$C = N(d_1)Se^{-q(T-t)} - e^{-r(T-t)}N(d_2)K$$

$$d_1 = \frac{\log(S/K) + (r - q + \sigma^2/2)(T - t)}{\sigma\sqrt{T - t}}$$

where:

 $\begin{array}{ll} d_2 = d_1 - \sigma \sqrt{T - t} & t = \text{current time} \\ C = \text{call option} & q = \text{continuous dividend yield} \\ T = \text{expiration date} & \sigma = \text{stock volatility} \\ S = \text{stock price} & r = \text{risk-free rate} \\ K = \text{strike price adjusted} \\ N(d_1) \text{ and } N(d_2) = \text{the cumulative normal distribution functions} \\ \text{for } d_1 \text{ and } d_2 \end{array}$

Next, we determine the bond value (*IV*, or investment value), the estimated fixed-income value of the convertible. The bond value is also used to discount the strike price of the convertible. That is because, in effect, the convertible is valued as a straight usable bond with a detachable warrant, and the warrant can only be exercised by surrendering the bond in lieu of cash. Therefore, the convertible strike price is discounted by the amount of the bond value's discount from par. Another complicating factor in this adjustment comes from estimating the probability of call and the appropriate investment value as a result of that probability, along with the probability of non-call and the corresponding investment value and call value.

$$IV = \sum_{t=1}^{n} CPN/(1+k)^{t} + par/(1+k)^{n}$$

where:

CPN =coupon, par = par value, k =credit-adjusted discount rate, n = number of periods to maturity. Adjusted strike price = K = IV/QEmbedded convertible equity value = W = C * QConvertible value = W + IV W = embedded warrant IV = investment value Q = conversion ratio

Although the Black-Scholes model with an attached bond is straightforward and calculable on a basic financial calculator, the model does not price the



FIGURE 1.8 Convertible Valued as Stock-Plus Put Option.

more complex structures with ease and it simply breaks down in a more dynamic environment.

Stock-Plus Method of Convertible Valuation

Some evaluate convertibles as a combination of the issuer's stock with a relative higher yield, plus a European put option. Instead of viewing a convertible bond as a fixed-income instrument with an embedded option, because of its convertible feature we can think of it as a stock, with a yield greater than its dividend. In adding these two components—the conversion value and the income stream—we still need to account for the fact that the security pays par value at maturity, even if the stock has declined. When valuing a convertible from this viewpoint, the par value's protection against stock declines is effectively a put. See Figure 1.8.

This approach has merit when evaluating some convertible structures. The stock value in this approach is simply the conversion value (stock price multiplied by the conversion ratio) and the put value represents the fixedincome value of the convertible. From this point of assessment, you presume the ability to convert the equity to fixed income or, to state it another way, you have the right to put the equity back to the issuer in exchange for a bond. The exercise price of the put option is the convertible's conversion rate. The valuation also includes the income-stream component, as the present value of the convertible income stream less the underlying stock dividend stream makes up the third component in this pricing technique. The put will not be exercised unless the conversion value of the convertible is below the conversion price at maturity or when called.

Parity = S^*Q

PV yield advantage = $(CPN - D)^n$

where D = stock dividend annual, CPN = annual coupon payment.

Put Value = $-N(-d_1)Se^{-q(T-t)} + e^{-r(T-t)}N(-d_2)K$

Strike = adjusted strike = K = IV/Q



In some circumstances, this model will be more intuitive and help frame the hedge and valuation decisions. Convertibles that are deep-in-the-money are the best candidates for this approach because they have a lower probability of maturing and the fixed-income value is significantly below the current price. Therefore, the deep-in-the-money convertibles valuation is derived primarily from its underlying conversion value and the income advantage above the underlying stock yield but some consideration must be assessed to the fixed-income value should the stock price decline precipitously before the call protection expires. This fixed-income value can be modeled and thought of as a put option and valued based on the probability of exercise given the expected stock price volatility over the call protection left on the issue. An example of the use of the stock-plus valuation model may help to understand its usefulness. 3Com Corporation had a convertible with the following terms:

3Com Corporation's 10.25% convertible bond due 11/01/2001. Stock price: \$50.75 Convertible Price: \$1,570.00 Conversion ratio: 28.9331 Call protect expires: 281 days

Since the convertible has such a high coupon rate relative to the current interest rate environment, we will evaluate this issue as if the company will redeem the bond as soon as it is available. The first call date is 11/15/1997 and the call price is \$1,029.30.

Valuation:

Parity = (stock price * conversion ratio) = (\$50.75 * 28.9331 shares) = \$1,468.35

Present value of convertibles yield advantage = (convertible income – stock dividend) discounted over the expected life of the security at the appropriate interest rate. This example = 74.40 = 0.265 per day received for the next 281 days discounted at the cost of money.

Put strike price = (convertible's investment value/conversion ratio) = (\$1,029.3/28.9331) = \$35.575

Put value = input option model: strike price \$35.575, time to expiration 281 days, stock price \$50.75, volatility 38%, European style expiration. This results in a put value = \$0.80 and the convertible's imbedded put value is \$0.80 multiplied by the conversion ratio (28.9331) for a total put value of \$23.15 per bond.

CONVERTIBLE ARBITRAGE

Combine the parts:

Parity	\$1,468.35	
Plus <i>PV</i> of cash flow	\$74.40	
Plus put value	\$23.15	
Total convertible value	\$1,565.90	as compared to the actual
		price of \$1,570.00.

This stock-plus valuation methodology for deep-in-the-money convertibles may help improve the arbitrageur's understanding of the current valuation and how to set up some possible hedge opportunities.

CONVERTIBLE PROFILE GRAPH

The convertible security in Figure 1.9 offers unlimited appreciation potential because as the stock price increases in value, the conversion option increases along with it. Indeed, many convertible securities have increased 500 percent and even 1000 percent! The graph also indicates that the convertible has limited downside risk; as the stock price declines to near zero, the convertible only trades down to the investment value, as represented by the horizontal line. In reality, if the underlying common-stock price declines and approaches zero, the company's credit is very distressed and the convertible declines to its liquidation value. Figure 1.9 demonstrates this new convert-



FIGURE 1.9 Degrees of Equity and Fixed-Income Sensitivity.



ible price track that includes the distressed credit range. The convertible arbitrageur must know the credit risk inherent in a position and monitor it closely to avoid the distressed credit zone. There are convertibles, however, that are not subject to the same company credit and equity risks inherent in most convertibles. For instance, some non-traditional convertibles are issued by companies of one credit rating and are convertible into another company's stock with a different credit rating. Because the basis for the credit rating depends on the credit quality of the issuer and not of the company stock, these exchangeable convertibles may avoid some of the distressed-credit risk. Principal-protected convertible structured notes and synthetic convertibles can also reduce this risk. These non-traditional convertible securities will be discussed in Chapter 9.

Figure 1.9 also demonstrates the varying degrees of equity and fixedincome sensitivity as the convertible moves along its price track. The "busted convertible" range means the convertible is out-of-the-money and considerably more sensitive to its fixed-income features than to its equity features. In our XYZ company example, the convertible is exercisable into 50 shares at a price of \$20. If the current stock price drops well below this level, say to \$5, the convertible trades in the busted range.

The "hybrid range" offers the traditional convertible benefits with both fixed-income and equity sensitivities. The convertible is said to be at-themoney, or the current stock price is very close to its exercise price. In our example, the stock may be plus or minus a few points from the exercise price of \$20 exercise or conversion price.

The "equity range" represents the range at which the convertible trades with a high degree of equity sensitivity and either a low degree or no fixedincome sensitivity. The convertible is said to be in-the-money, and in our example any stock price above \$30 will trade with a high degree of equity sensitivity. At a \$30 stock price, the conversion value is \$1,500 per bond.

BASICS OF CONVERTIBLE ARBITRAGE

The traditional convertible arbitrage position entails purchasing long an undervalued convertible bond and selling short the underlying common stock. The amount of stock sold short is a function of the number of shares the bond converts into (conversion ratio), the equity sensitivity of the issue (delta), and the sensitivity of the delta to changes in the stock price (gamma). (The greeks receive scrutiny in Chapter 3.) The objective of the hedge is to produce a risk-return profile that offers an attractive rate of return regardless of the direction the stock moves; it will be discussed in more detail in Chapter 5. The cash flow from the convertible's coupon payment, along



FIGURE 1.10 Traditional Convertible Hedge Profile.

with the short interest credit created from the short stock account, provides a good base return. The hedge will often benefit from movements in the underlying stock and the convertible's non-linear relationship to the stock, offering the arbitrageur additional gains potential. Finally, if the hedge is established when the convertible is undervalued, additional profit potential exists. The traditional convertible hedge profile involves adding to the short stock position as the stock price increases (and the convertible's delta increases), and covering a portion of the short stock position when the stock price declines (and the convertible's delta decreases). See Figure 1.10. As Meyer Weinstein instructed in 1931, the appropriate number of shares to short against the long convertible can determine the hedge's success. Shorting too many shares can cause the hedge to lose money if the stock price increases, and shorting too few shares can cause a loss should the stock price decline. Since each convertible converts into a predetermined number of shares of stock, and a delta can be determined for each convertible, then the appropriate basic hedge ratio is determined by multiplying the delta by the conversion ratio.

Neutral hedge ratio = (Conversion ratio \times delta)

In general, convertible arbitrageurs look for convertibles that exhibit the following characteristics:



- 1. *High volatility*—An underlying stock that demonstrates volatility that is above average. The more volatile the stock, the greater the likelihood of garnering trading profits by re-establishing the hedge ratio.
- 2. Low conversion premium—In general, a convertible with a conversion premium of 25 percent and under is preferred. A lower conversion premium typically means lower interest-rate risk and credit sensitivity, both of which are more difficult to hedge than equity risk. Event risk, such as a merger or takeover, surprise call, or special dividend, can also prompt a conversion premium to collapse and implode the hedge: The lower the conversion premium, the less the premium collapses.
- 3. Low or no stock dividend on the underlying shares—Since the hedge position is short the underlying shares, any dividend on the stock must be paid to the long stockowner, creating negative cash flow in the hedge.
- 4. *High gamma*—A convertible with high gamma offers dynamic hedging opportunities more frequently, thus offering the possibility of higher returns. High gamma means the delta changes rapidly.
- 5. Under-valued convertible—Since the hedged convertible position is still "long-volatility," the arbitrageur seeks issues that are undervalued or trading at implied volatility levels below the expected norm. The hedge position will provide an additional return if under-valued securities move back to normal pricing.
- 6. *Liquidity*—The more liquid issues are preferred as a means to quickly establish or close a position.
- 7. Below-investment-grade issues with identifiable investment values—The source of a significant amount of mispricing in the convertible marketplace is due to issues with unclear credit profiles. The arbitrageur must determine the credit quality of an issue to determine the proper hedge ratio. He or she must have a sense of the downside risk in the convertible in order to hedge against a sharply declining stock price.
- 8. *Stock availability to borrow*—The shorted shares must be available to borrow. Many convertibles that appear undervalued do so because the stock borrow is difficult and the mispricing cannot be easily realized.
- 9. Equitable terms and protection—Many convertible prospectuses offer an array of terms and potential risks. The convertible arbitrageur needs to know the answers to many questions, such as: Upon conversion or put, does the issue pay in stock or cash? Does the issue offer take-over protection? Upon conversion due to a non-voluntary call, will the convertible pay its coupon or dividend? Is the convertible protected against special dividends on the underlying stock? What are the terms of a call or a put option? What is the default status of the issue?

MULTIPLE CONVERTIBLE STRUCTURES

In addition to the traditional convertible bond, many other equity-linked convertible structures exist and more will undoubtedly surface as financial engineering continues to meet the needs of issuers and buyers. The convertible structures range from debt-like to equity-like in their sensitivities. At one end of the spectrum, zero-coupon convertibles and OID convertibles have the most debt-like characteristics at issuance, while mandatory convertibles are issued with the most equity-like characteristics. See Figure 1.11. In the after-market, as equity prices and interest rates change, the characteristics of the various structures can change considerably.

Convertible Preferred Stock

Instead of the traditional convertible structure of a long bond with an embedded equity option, the convertible preferred is structured as a traditional preferred stock with an embedded equity option. In practice, convertible preferred stock behaves similarly to traditional convertible bonds with a long term to maturity. Since preferred stock is lower in the capital structure in regards to claim on assets in the event of default, the credit risk is higher than all other debt holders; only equity holders are lower than preferred holders in this regard. Because of the lower seniority and long term to maturity—if any, the convertible preferred will offer a higher yield than an equivalent convertible bond. The convertible preferred market has tradi-



Debt Characteristics

Equity Characteristics

FIGURE 1.11 Convertible Structures—Debt and Equity Characteristics.

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tionally been a mainstay in the convertible universe, representing approximately 15 percent to 40 percent of the outstanding market in the previous two decades. In the past, most convertible preferred did not offer an obligation to pay principal value at any time in the future, but many of the new trust-structured convertible preferred now offer a maturity date and principal payment at maturity.

The typical convertible preferred stock pays a quarterly dividend at a fixed rate, while the trust-structure issue pays quarterly interest. Truststructure preferreds are issued through a subsidiary trust to effectively turn the non-tax deductible dividend issued by the company into a deductible interest payment for the company. Trust-structure preferred are known by numerous acronyms, including: MIPS, TOPrS, QUIPs, TECONS, and BUCS. The purchaser of the trust-structured convertible does not receive the DRD (dividend received deduction) for tax purposes. A trust-structure preferred has a maturity date generally ranging from 20 to 30 years, with a principal payment due.

The flow chart in Figure 1.12 demonstrates how the trust structure is a special purpose vehicle that the issuer guarantees with the sole purpose of changing a preferred dividend payment into a tax-deductible interest payment. The issuer issues a subordinated note to the trust and the trust issues the convertible preferred. The proceeds of the issue flow back through the trust to the issuer. The capital raised is consolidated, and appears as only preferred stock on their balance sheet.

The evaluation of a convertible preferred is similar to valuing a convertible bond, with the exception of long-dated paper with or without principal payment. Convertible arbitrageurs need to address the higher degree of volatility that comes with a longer-term structure with low claims status, but convertible preferred issues are a very active part of the arbitrage marketplace.

Zero-Coupon Convertible Debt

The most bond-like convertible structure is the zero-coupon convertible bond. The zero-coupon bond, as its name implies, does not pay cash interest but instead the bond carries a series of accreting put options. In effect, the



FIGURE 1.12 Trust-Structured Convertible Preferred Securities.

buyer has paid for the series of put options with the coupon stream he forgoes. The issuer can still deduct the phantom interest payment for tax purposes, making the structure more attractive for the issuer. The recent advent of contingent interest convertibles even allows the issuer to deduct their fair straight debt rate, turning the security into a high positive cash-flow vehicle for taxable issuers. That is because the convertible accretes at the lower rate stated in the prospectus and includes the conversion feature, while the issuer deducts interest at the straight-bond equivalent rate that may be 2 percent to 6 percent higher. The zero retains more bond-like features at issue because the put feature provides a bond floor that is close to the current value and this bond floor (put) accretes each year, helping to reduce downside equity risk. The zero-coupon also has a low degree of interest rate risk because of the short-term duration of the series of puts. See Figure 1.13.

Valuation of the zero-coupon convertible must include the series of puts as well as the series of call options that both issuer and buyer can claim as their right. Valuing the zero-coupon convertible as a zero-coupon bond with a call option is partially correct, but the likelihood of putting the bond back to the issuer before a call occurs is also important to proper valuation. The basic long stock plus long put model helps here. Combining the likelihood of the buyer exercising a put with the likelihood of the issuer calling the issue with these two models does a good job at approximating fair value. But, as we will see in Chapter 2, the binomial lattice tree model does a good job of handling these multiple options.

These options are generally not complicated, and arbitrageurs navigate the zero-coupon market quite well. In general, the zero-coupon bond offers better credit ratings and more secure downside hedging for the arbitrage community. But, the lack of income flow, a very important component of total return in the hedge profile, makes these issues less desirable. The series of options embedded in the zero-coupon structure does, however, offer some interesting arbitrage opportunities and hedge profiles, some of which will be discussed in further chapters.

Mandatory Convertible Preferred Issues

Mandatories, the most equity-like of convertible issues, go by the acronyms of DECS, PERCS, PRIDES, ELKS, and so on. Each of these issues is considered a preferred stock whose conversion into common stock is mandatory, usually in three years from issuance. The mandatory convertible offers high dividend yields and a cap or partial cap to upside equity participation. The risk-return profile of a mandatory convertible is very different from the traditional convertible security. Figure 1.14 shows the typical PERCS risk and reward profile. The PERCS security offers a high dividend yield but the up-

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XYZ Inc. 0% Due 2020 (LYONs) Risk/Reward Table

	Time	Stock Px % Change	Bond Px % Change	Convertible Participation
•	1.00 yr	-32.3	-2.1	6.5%
	.50 yr	-24.1	-1.4	5.8%
	.50 yr	+31.8	+16.2	50.9%
*	1.00 yr	+47.8	+24.9	52.1%

FIGURE 1.13 XYZ Inc. 0% Due 2020. (LYONS: Liquid Yield Option Notes.)

side participation with equity price moves is capped generally in the 40 percent to 80 percent range. Valuation of a PERCS is relatively simple because it consists of a long stock that it is convertible into and a short of an out-ofthe-money European-style call option, plus a yield advantage above the common stock. The short out of the money call option provides the additional yield advantage above the common stock but also caps the upside return. Convertible arbitrageurs may find some hedge opportunities when the embedded short call option is mispriced relative to call options available in the public market, or when the present value of the income stream is not properly discounted.

Another more popular mandatory convertible is the DECS structure. The DECS include multiple options and offer a better risk-reward profile than a PERCS. The DECS structure can be valued as long stock plus short a



FIGURE 1.14 Mandatory Convertible—PERCS Risk-Reward Profile.

European-style call option at-the-money, plus long a European call option out-of-the-money, plus the present value of the dividend-stream yield advantage. The short European call option is the lower trigger in Figure 1.15 and is usually struck at the current stock price at issue and has a conversion rate equal to one. The second option is a long European call option indicated as the upper trigger and is usually from 15 percent to 30 percent out-of-themoney at issue. The upper trigger has a lower conversion rate than the lower trigger—typically 80 percent of the lower trigger rate. The area between the two triggers is a flat spot or "deck" where the issue does not gain or lose significant values with stock price movement. Below the lower trigger, the security declines one-for-one with the stock, but has a higher dividend yield. The price area greater than the upside trigger provides upside appreciation with the stock price movements but at a lower conversion rate, therefore returning around 80 percent of the stock's upside.

Mandatory convertible securities are popular with equity investors and equity-income funds. They also provide some very good hedge opportunities for the arbitrage community because of price discrepancies that occur and the high degree of certainty at maturity payoff. Chapter 6 will present a detailed discussion about hedging mandatory convertibles with stock or options.

Figure 1.15 shows the DECS risk-reward profile at maturity. Because of the multiple options long and short, it is helpful to see the at maturity payoff structure to understand the dynamics of the security. Figure 1.16 demonstrates





FIGURE 1.15 Mandatory Convertible—DECS Risk-Reward Profile at Maturity.



FIGURE 1.16 Mandatory Convertible—DECS Risk-Reward Profile.

CONVERTIBLE ARBITRAGE

the theoretical price track for the DECS at issuance and also with only three months to maturity. As you will see later, profitably hedging a mandatory convertible is not as straightforward as a vanilla convertible because of the volatility and dynamics of the greeks inherent in this structure.

APPENDIX 1.1 Return Statistics and Correlation Matrix to Other Hedge Strategies, January 1990 to December 1999 (Risk-Free Rate Subtracted).

Strategy	Average monthly return	Monthly standard deviation	Correlation to S&P 500	Beta to S&P 500	Alpha
S&P 500	0.8620	3.870	1.000	1.000	0.000
Convertible Arbitrage	0.5159	1.019	0.4027	0.106	0.425
Fixed- Income Arbitrage	0.3609	1.429	-0.0956	-0.037	0.393
MBS Arbitrage	0.4838	1.337	-0.0310	-0.013	0.499
Equity Hedge	1.4256	2.527	0.6453	0.421	1.063
Equity Market Neutral	0.5178	0.973	0.2548	0.064	0.463
Statistical Arbitrage	0.5273	1.088	0.4735	0.133	0.413
Merger Arbitrage	0.6054	1.339	0.5040	00.174	0.456
Relative Value Arbitrage	0.7213	1.191	0.3477	0.107	0.630

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	Convt. Arb.	Equity Hedge	Equity MN	F.I. Arb.	Merger Arb.	RVA	Stat. Arb.	MBS Arb.	Bonds	Stocks
Convt. Arb.	1.0									
Equity Hedge	0.516	1.0								
Equity MN	0.183	0.466	1.0							
F.I. Arb.	0.124	0.036	0.0067	1.0						
Merger Arb.	0.482	0.473	0.149	-0.082	1.0					
RVA	0.552	0.518	0.201	0.308	0.392	1.0				
Stat. Arb.	0.187	0.252	0.577	0.096	0.244	0.200	1.0			
MBS Arb.	0.360	0.138	0.234	0.658	0.089	0.331	0.116	1.0		
Bonds	0.230	0.137	0.184	-0.274	0.114	0.042	0.427	0.111	1.0	
Stocks	0.398	0.642	0.246	-0.100	0.499	0.345	0.483	-0.033	0.395	1.0

Correlation Matrix of Market Neutral and Hedge Strategies, 1990–1999.