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The background of the cover features a complex financial chart with various elements: a candlestick chart on the left, a line graph with a downward arrow, and a bar chart with a downward arrow. The overall color scheme is dominated by reds, oranges, and yellows, with a dark, textured background that suggests a financial or industrial setting.

The Handbook of Convertible Bonds

*Pricing, Strategies and
Risk Management*

JAN DE SPIEGELEER
WIM SCHOUTENS
Foreword by Philippe Jabre

The Handbook of Convertible Bonds

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Pricing, Strategies and Risk Management

Jan De Spiegeleer and Wim Schoutens



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To Klaartje, Charlotte, Pieter-Jan and Willem

—*Jan*

To Ethel, Jente and Maitzanne

—*Wim*

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Reading This Book

The target audience for this work on convertible bonds is very broad. The absolute beginner will find in it a sufficient course to become familiar with the convertible bond universe. The more advanced audience, consisting of arbitrageurs, portfolio managers or quantitative analysts, will discover the application of methods such as American Monte Carlo simulation. These techniques are mainstream methods in exotic derivative pricing but have not yet made their landing on the convertible bond desks. Convertible bond pricing is ruled by the finite difference method and binomial trees. These latter techniques are generally bottlenecks when one wants to apply multifactor models to the convertible bond valuation. As many numerical examples as possible have been added to enrich this book, while omitting the non-essential mathematics. The book covers more than the valuation of convertible bonds. An in-depth coverage of the risk management of a convertible bond portfolio has been provided. In the risk management section there is also a lot of material covering the gamma trading of a convertible bond portfolio.

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Preface

Hard work always pays off and convertible bond investing is no exception to the rule. I spend my life constantly watching the financial markets to try to anticipate moves and understand drivers and catalysts. Researching, meeting and visiting companies, reading books, reading the newspapers and talking to our investors, are all elements that lead to an edge. This is the edge that will let you outperform your peer group. The job is not done when the markets close. One is never on holiday.

Building a business investing in bonds, shares and currencies has to be founded on a good working knowledge of the market dynamics. The financial markets are booby-trapped with rules, equations, models, technical analysis and arithmetic trying to explain how the system 'should work'. Very often this turns into investment fundamentalism where the professional forgets to question the foundations on which all of these techniques have been built. Financial engineers have created a world that is easy to understand, to model and to endlessly replicate. Unfortunately, this is a dangerously fake world, distant from the unpredictable reality. Credit spreads are linked to equity price levels and volatility changes are regressed against share price movements as if this was an economical truth. Models very often do not provide for a liquidity event and do not include transaction costs. A number of financial 'shops' have been built on and subsequently destroyed by these laws of finance.

If you are thinking that I invested in convertible bonds for over 20 years ignoring models, you are wrong. On the contrary, I encourage everyone to study and understand formulas and other technicalities and use them intelligently as they will help you to figure out how your competitors think, and if you use them proactively they can help you to react to a changing market environment. For this reason I very much welcome this handbook on convertible bonds written by Jan and Wim. It deserves a place on the desk of anyone with an interest in entering the convertible bond universe. The authors go beyond the traditional approaches; they offer workable alternatives to avoid the pitfalls created by the classic Black and Scholes look-alikes.

In 1973, almost 100 years after the first convertible bond was issued and 50 years after the first convertible arbitrage strategy was set up, the Black and Scholes formula saw daylight. Black and Scholes electrified option trading. This is undoubtedly to their great merit. Unfortunately, their revolutionary equation fed the conviction that markets can be modelled and that risks can be hedged and sold away. If I was a passive taker of this formula, I would not be here right now. After 30 years in the market, I have learned to scrutinize everything. This has transformed me into an unconventional convertible bond player: not a traditional long-only investor, nor

a convertible bond arbitrageur, but one or the other when it seems most appropriate. Being polyvalent is the key for survival and success.

The pricing model of a convertible is a means to reach a goal, it is not the goal itself. If the pricing model was crucial, the only driver of convertible bond investing would be the cheapness of the bond. People often forget that your pricing model dictates the way you look at the hedging of the convertible position. Having a view on the underlying company is the most important thing. This has been clearly illustrated in some hedging examples covered in this book. A convertible bond position gives exposure to the whole balance sheet. You need a view on the credit of the issuer, a target level on the share price and a target level for the volatility in the embedded option. Most of the time you will be on your own to make this call; there will be no listed options to benchmark the convertible against. In most cases, you will not find a liquid credit default swap market to hedge the credit risk, and doing your homework is the only option left.

Philippe Jabre
Founder and CEO Jabre Capital Partners

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Part I

The Convertibles Market

Terminology

Gentlemen prefer bonds.

Andrew Mellon (US financier philanthropist, 1855–1937)

Convertible bonds have been around for more than a century. They are a spin-off from the traditional corporate bond market. The main difference is the fact that the buyer of convertible debt has the possibility to convert the convertible bond into shares of the issuing company. What makes these bonds challenging and at the same time interesting, is that their behaviour is on the crossroad of three asset classes: equity, fixed income and, to a lesser extent, currencies. The pricing and risk management of convertible bonds has benefited enormously from the advances in the equity derivatives scene and the advent of credit derivatives. In the equity derivatives discipline, for example, our understanding has moved a long way from the Black and Scholes breakthrough in 1973 to the introduction in the 1990s of the more advanced stochastic volatility models. The credit default swap market can be credited for bringing the concept of default intensity and recovery rates into the area of convertible bonds. This chapter provides a mandatory introduction into the standard terminology of this asset class. After reading this chapter, one will have mastered convertible slang.

1.1 THE PAYOFF

Hybrid securities are securities with both debt and equity characteristics. The most important family member of this asset class is the convertible bond. A convertible bond is a security in which the investor can convert the instrument into a predefined number of shares of the company that issued the bond. This conversion is, by default, not mandatory and is an option for the investor.

Convertible bonds are not new. We have to go back as far as 1881 to find the issue of the first convertible bond. The railroad magnate J.J. Hill needed an innovative way to finance one of his new projects because nobody was interested in buying any equity when he wanted to increase the capital in his railroad company. The convertible bond market has evolved a lot since this first issue more than a century ago, but the principle of mixing debt and equity in one single instrument remains the same. The final payoff of the convertible bond is written as:

$$\max(N, C_r \times S) \tag{1.1}$$

The holder of this convertible has the right, at maturity, to swap the face value N of the bond for C_r shares with price S , where C_r is the conversion ratio. Hence, a simplified definition of a convertible bond is a bond with an embedded call option. Rewriting (1.1) and abstracting from the fact that the convertible might pay coupons illustrates this:

$$N + \max(0, C_r \times S - N) \tag{1.2}$$

The above argument is only possible when the conversion is restricted to the maturity of the convertible bond. Actually, by put–call parity, holding a convertible bond is also economically the same as holding C_r shares combined with a European put option to sell these shares in return for the face value N of the convertible bond:

$$C_r \times S + \max(N - C_r \times S, 0) \tag{1.3}$$

Some simplified valuation methods support this breakup. These methods try to value a convertible as a package consisting of a European option on a stock and a corporate bond. Convertible bonds are issued by corporates (the issuer) but we cannot simply categorize them as debt. They rank before the common stockholders, and their behaviour can move from being a pure bond to an equity-like security. All of this depends on the behaviour of the underlying common stock, into which the convertible can be converted. In the case when the conversion value ($C_r \times S$) is high enough, the holder of the convertible (the investor) will exercise his or her conversion right. This could happen if the dividend yield earned on the shares is high enough compared to the coupon earned on the bond. On a non-dividend paying stock, conversion will not happen prior to maturity. A company issuing a convertible can be seen as selling shares on a forward basis. The above example is limited to the possibility of converting at maturity. Most convertibles are American-style in their conversion possibilities: converting the bond into shares is not limited to the maturity date only. Conversion can happen during a predefined conversion period ($\Omega_{\text{Conversion}}$).

The value $C_r \times S$ is called the conversion value C_V or parity P_a . Next to the conversion feature there is also a possibility for the bond to be called by the issuer. The issuer has, during a certain call period (Ω_{Call}), the right to buy back the outstanding convertible security at a price K . This is the call price. In legal documents regarding convertibles, this is often called the early redemption amount. The moment the bond gets called, the investor can still convert into shares even when $t \notin \Omega_{\text{Conversion}}$. This is called a forced conversion and is different from (1.2), which stands for an optional conversion. After receiving a call notice from the issuer, the rational investor will convert if:

$$C_r \times S > (K + \text{Accrued Interest}) \tag{1.4}$$

The conversion into common stock and the possibility of being called are the two basic building blocks present in most hybrid securities. In the next section, additional features will be discussed using a real-world example.

1.2 ADVANTAGES OF CONVERTIBLES

For both issuers and investors there are several advantages in issuing hybrid capital or investing in hybrid securities. According to the Modigliani–Miller theorem, the capital structure has no relevance. A company looking to raise capital should be indifferent to the way this capital is raised. Equity or debt, it doesn't really matter [78]. Their Nobel prize-winning paper is based on a perfect world with no taxes, and all information is available to everyone. A company cannot optimize its cost of capital by choosing a perfect mix of debt and equity. The reality is different however.

1.2.1 For the Issuer

Cost of capital consideration

Academic theory considers it a myth that the argument that the coupon on a convertible is less than the coupon on equivalent corporate debt, making the convertible the ideal instrument from a cost of capital point of view [28]. A treasurer or financial director of a company is not going to make the choice between issuing shares or corporate or convertible debt solely based on the annual coupon. If the share price rises in the future, the extra dilution after the conversion of the debt into shares would not maximize the value for the current shareholders. A company that is expecting a long-term rally on its shares would be better off issuing corporate debt. If the CFO is 100% certain that the share price is going to drop going forward, the shareholders would be better off having issued new share capital. But all of this is built on assumptions and wishful thinking. It is impossible to predict share prices. It would also imply that good companies issue debt and bad companies issue equity.

For growth companies, the lower coupon argument still stands, however. It might be a very good reason to opt for convertible debt as companies might run tight budgets in the first years after the issue date. A capital intensive growth company that is looking for a lighter interest rate charge will therefore prefer convertible debt over corporate debt. Table 1.1 provides for a handful of converts a comparison between the current yield¹ on the convertible bond and the current yield on a corporate bond issued by the same issuer of the convertible. For each of the convertibles in the list a corporate bond issued by the same company is used as comparison. The current yield on the convertibles is clearly lower than the yield on corporate debt of the same issuer. The difference in yield is compensated by the embedded right to convert the convertible bond into shares at the discretion of the investor.

Monetization of risk

A company with a high degree of business risk will be charged a higher cost of capital by the bank from which it wants to get a loan or from the investors through which it wants to raise corporate debt. If this company has its shares listed on a stock exchange, the share price will be volatile and options will be adequately priced. Using a convertible, the company could monetize this high volatility. The conversion feature packaged into the convertible bond is worth a lot more on volatile underlying shares. The embedded equity option in the convertible is then more expensive. This enables the company to lower its interest rate charge.

Privatization

A convertible issue is a forward sale of shares. The investor can be forced into the purchase of shares when the company decides to call back the debt. This forward sale mechanism can be used by a government that wants to dispose of some of its stakes in industrial companies. An example is the convertible issued in September 2009 by the Hungarian State Holding Company. This 5 year 4.4% quasi-sovereign bond had the backing from the Hungarian state and could be redeemed into shares of Gedeon Richter, a pharmaceutical products company located in Hungary. As long as these bonds – which tend to be named exchangeables instead

¹ The current yield (CY) is defined as the coupon rate divided by the market price of the instrument.

Table 1.1 Comparison of the current yield on some convertible and corporate bonds issued by the same legal entity. All the prices and yields were taken on 20 October 2009. (Source: Bloomberg)

Name		Current yield (%)		Maturity (Years)	
CB	Bond	CB	Bond	CB	Bond
Air France-KLM	2.75% 1-Apr-20	2.73	4.82	2.09	4.24
Alcatel	5% 1-Jan-15	4.78	6.52	1.74	4.44
Anglo American	4% 7-May-14	2.96	5.51	2.55	5.47
ArcelorMittal	7.25% 1-Apr-14	4.72	7.43	2.71	3.60
Clariant	3% 7-Jul-14	2.22	4.46	2.24	3.44
EFG Eurobank	1.7% 29-Oct-14	1.70	4.35	2.65	3.29
Gedeon Richter/MNV	4.4% 25-Sep-14	4.35	6.29	1.94	4.75
Graubundner Kantonalbank	2% 8-May-14	1.96	2.08	0.12	5.79
Nexans	4% 1-Jan-16	4.32	6.09	1.77	7.51
TUI	2.75% 1-Sep-12	3.62	6.28	2.65	3.12
Vedanta	5.5% 13-Jul-16	4.98	9.31	4.33	8.72
Alcoa	5.25% 15-Mar-14	2.51	5.66	3.15	3.71
Allegheny Tech	4.25% 1-Jun-14	4.25	8.21	3.96	9.59
Best Buy	2.250% 15-Jan-22	2.10	6.29	4.19	3.71
BorgWarner	3.5% 15-Apr-12	2.80	5.62	2.82	7.01
PHH Corp	4% 1-Sep-14	4.00	7.50	3.50	3.34
Superior Energy Services	1.5% 15-Dec-26	1.66	7.12	5.46	4.59
Air France-KLM	0.75% 22-Jan-14				
Alcatel	6.375% 7-Apr-14				
Anglo American	5.875% 17-Apr-15				
ArcelorMittal	8.28% 3-Jun-13				
Clariant	4.375% 5-Apr-13				
EFG Eurobank	4.375% 11-Feb-2013				
Gedeon Richter	6.75% 28-Jul-14				
Graubundner Kantonalbank	2.125% 12-Aug-15				
Nexans	5.75% 2-May-17				
TUI	5.125% 10-Dec-12				
Vedanta	9.5% 18-Jul-18				
Alcoa	6% 15-Jul-13				
Allegheny	9.375% 1-Jun-19				
Best Buy	6.75% 15-Jul-15				
BorgWarner	5.75% 1-Nov-16				
PHH Corp	7.125% 1-Mar-13				
Superior Energy Services	6.875% 1-Jun-14				

Table 1.2 Description of Gedeon Richter 4.4% 25-Sep-2014

ISIN	XS0451905367	SEDOL	B4269L7
Issue Date	25-Sep-2009	Issue price	100%
Issue Size	833m		
Stock	Gedeon Richter	Issuer	Hungary
Stock Currency	UF	Bond currency	EUR
Conversion Ratio	561.7041	Face Value	100,000
Redemption	100.00%	Maturity	25-Sep-2014
Coupon	4.4% (30/360)	Frequency	Annual
Call Type	–		

of convertible bonds – are not converted, the original share holder is still entitled to all the normal share holder rights such as dividends. The details of the bond are given in Table 1.2.

Dilution

The dilution of earnings is postponed until the convertible is converted into shares. At this conversion date, the earnings per share are reported on the current outstanding number of shares.

In most annual reports, depending on the legal jurisdiction, the diluted earnings per share can also be found. This number takes all shares into account, including those resulting from a conversion of the convertible debt issued by the company. The convertible also has a limited announcement effect on the share price [72]. This is the effect on the share price a short period after the announcement of raising capital. Each method has a different announcement effect. A straight equity issue in the US domestic market has a negative impact on the share price between -2% and -4% [72]. When a corporate announces a new convertible issue on the other hand, the effect on the share price is much smaller and sometimes insignificant. All of this is a function of how equity-like the convertible issue is. Announcing a capital increase through a convertible bond with a very low conversion ratio will have a small impact on the price of the shares. The higher the conversion ratio, the higher the possible future dilution and the higher the announcement effect of the new issue. The dilution needs to be put in a probabilistic framework, because it depends on the path followed by the share after the bond is issued. Investors will only convert if the share price is above the conversion price. The announcement effect is therefore dependent on the expected probability that the convertible will be converted into shares.

Tax treatment

If an issuer were to issue shares this extra amount of capital would need to be serviced with dividends. Dividends come from after-tax profit, whereas interest payments on debt are tax deductible. This makes the convertible bonds preferable to issuing equity from a tax perspective.

Tailor-made solution

There is no such thing as a convertible bond prototype. The different instrument features can quickly be combined to construct an instrument that fits the capital needs of the issuer but still offer an attractive payoff to the investor. Since the inception of the Black–Scholes model,

derivative pricing has made a revolutionary progress. The knowledge base on the investor and issuer side is definitively large enough to cope with this sophistication. One of the features is the call embedded in the convertible. It gives the issuer the right to call back the debt and pays the investor in the bond an early redemption amount. It gives the issuer the right to refinance the debt if the possibility arises to do so at lower rates. The issuer has, through the embedded call feature, a put on the interest rate and the credit spread. On receiving a call notice, the investor can convert into shares and will do so if the value of the shares received is greater than the early redemption amount. Forcing a call upon the investor changes the balance sheet: debt gets taken off and is replaced by equity, which strengthens the capital structure of the company.

Rating agency

An issuer piling up his balance sheet with debt will witness the cost of borrowing on new debt go up. Rating agencies could act on this new information by downgrading the credit rating of the company. All of this will be a function of the business outlook of the company and the allocation of this debt to new projects. But for convertible debt there are considerations that could soften the approach taken by the rating agencies [111]. Convertible preferreds, for example, often have no maturity date. There is therefore no binding commitment by the issuer to return the capital to the investor. The coupon payments on preferreds – market practitioners prefer to use the term dividends – can be deferred if certain conditions are met. Skipping a dividend payment on a preferred does not constitute a default event. Accordingly [70], preference shares are issued by financially weaker companies. However in hindsight, the avalanche of such preference shares issued in the first half of 2008 was clearly a warning that a lot of bad news was coming to the market. This eventually materialized in the second half of the year, when the financial crisis almost turned into an armageddon.

1.2.2 For the Investor

Restricted investor

A traditional convertible bond can be considered as a fixed income instrument. It has a face value, a limited maturity where the face value will be paid back and has a regular annual or semi-annual coupon. A fund manager might have a mandate to invest into fixed income instruments only. This restriction will prevent this investor, who is, for example, running a corporate bond fund, from making an allocation to the stock market. A convertible bond offers

Table 1.3 Description of Bulgari 5.375% 8-Jul-2014

ISIN	XS0434384920	SEDOL	B59VQM2
Issue date	8-Jul-2009	Issue price	100%
Issue size	150		
Stock	Bulgari	Issuer	Bulgari
Stock currency	EUR	Bond currency	EUR
Conversion ratio	10,000	Face value	50,000
Redemption	100.00%	Maturity	8-Jul-2014
Coupon	5.38%	Frequency	Semi-annual

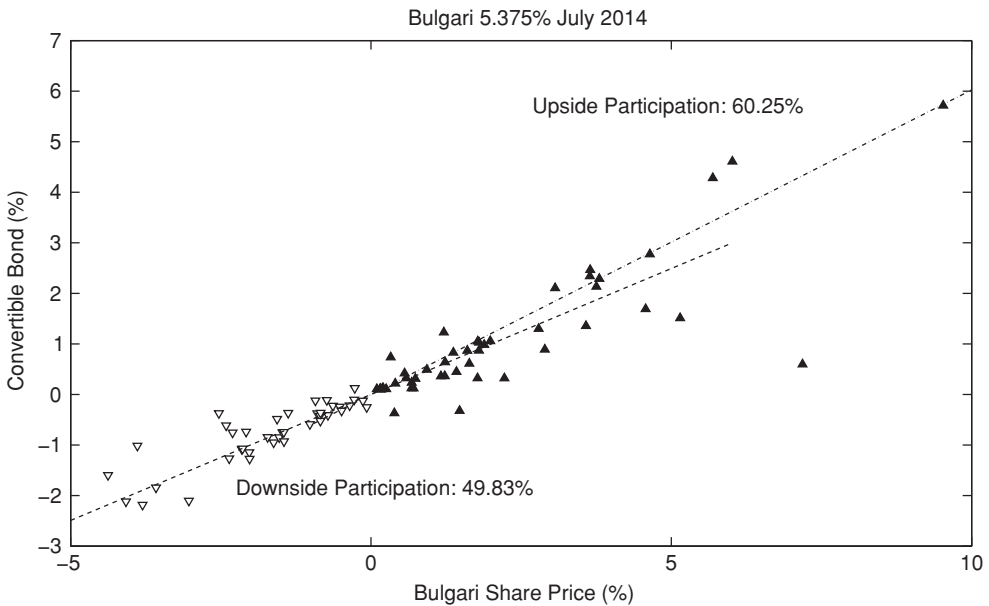


Figure 1.1 Daily returns of the share price of Bulgari versus the daily returns on the convertible bond. Observation period: 8 July, 2009 till 15 October, 2009. The days with a positive return (▲) are plotted next to the days where the share price had a negative return (▽). (Source: Bloomberg)

the best of both worlds and allows the manager to adhere to the investment guidelines of the fund but at the same time make an allocation to equity exposure.

Limited downside

Investing in convertible bonds is often said to be investing for the upside with a limited downside. To illustrate this point we look at the convertible bond issued by Bulgari, the luxury Italian watchmaker. The size of the issue was EUR 150m, and this convertible was launched in the summer of 2009. Further details can be found in Table 1.3. We studied the way a change in the underlying Bulgari share price is linked to the return on the convertible. Figure 1.1 plots the day returns of Bulgari versus the day return of the convertible bond. The linear regression between those returns is different depending on whether the share goes up or down. Using least squares we can construct the participation ratios.² On the upside the convertible participated with a factor of 60.25% in the increase of the share. But when the share had a negative day, the convertible participated less in the drop: the percentage drop in the convertible price was 49.83% of the negative return of the share price. This is convexity at work. The convertible holder is more and more exposed to the underlying shares as the price of these shares increases. When the share price drops, the holder suffers less. This limited 3-month data sample in the life of the Bulgari convertible can also be extrapolated to other names, and each time one will find the same dampening effect of the convertible structures. Convertibles decrease less

² Market practitioners will use the word delta and not participation ratio.

Table 1.4 Annual performance and volatility data of the BofA Merrill Lynch Global Convertible Index versus the MSCI. (*Sources:* Bloomberg and BofA Merrill Lynch)

Year	Return		Volatility	
	Merrill	MSCI	Merrill	MSCI
2001	(4.74)	(15.25)	7.19	17.20
2002	(3.53)	(25.20)	5.71	21.12
2003	13.91	22.75	3.54	14.42
2004	5.23	9.49	3.88	8.83
2005	5.97	13.74	3.76	7.47
2006	12.82	13.52	5.42	9.23
2007	6.53	2.83	7.40	12.55
2008	(29.35)	(40.11)	14.15	31.39
2009	36.19	22.82	8.93	20.55

than the underlying and this is the very fundamental reason that a convertible is a less volatile holding than an investment in the underlying share.

Portfolio optimization

In Table 1.4 the return of the convertible bond universe is compared to the equity returns. For the convertible data we used the well-known BofA Merrill Lynch Global Convertible 300 Index (MLG 300) and for the equity markets we took the MSCI World Index expressed in local currencies. This table clearly illustrates the low volatility of convertible bond investing. Recently, in 2008, we recorded an annualized historical volatility with double digit numbers. The 2009 return numbers illustrate the impressive recovery made by the convertible index compared to the performance of the MSCI in 2009.

A convertible bond has a positive convexity. This property will be the focus of our attention later in the book. Table 1.4 shows the limited historical volatility of the MLG 300 Index compared to MSCI. Adding convertible bonds into a portfolio of bonds and equity delivers a positive effect. We can illustrate this using the capital asset pricing model (CAPM). In finance, CAPM is used to theoretically model the returns of shares. One of the cornerstones in portfolio theory resulting from this model is the efficient frontier. For a portfolio with different components each weighting scheme gives a particular expected risk and expected return. These numbers can be calculated starting from the expected risk and return of the individual assets in the portfolio. The efficient frontier is formed by those combinations of assets that offer, for a given return, the lowest expected risk. In Figure 1.2 the efficient frontier for a portfolio with corporate bonds and shares has been calculated. The equity markets were modelled through the MSCI Index while the iBoxx Investment Grade Index was used to represent the corporate bond universe. The horizon over which the different risk and returns were estimated covered the period from January 2005 to January 2008. We omitted the turbulent 2008 from this analysis. The efficient frontier is upward sloping and shows how the expected risk of the portfolio increases by changing the portfolio composition for the highest returns. In this equity–bond framework, the only way to make more profit seems to be to add more risk. But allowing less correlated asset classes in the universe can offer an investor higher expected returns while keeping the risk unchanged. This happens when convertible bonds are added to the portfolio.