Simulating Convertible Bond Arbitrage Portfolios

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Abstract

The recent growth in interest in convertible bond arbitrage (CBA) has predominately come from the hedge fund industry. Past empirical evidence has shown that a CBA strategy generates positive monthly abnormal risk adjusted returns. However, these studies have focused on hedge fund returns which exhibit instant history bias, selection bias, survivorship bias and smoothing. This paper replicates the core underlying CBA strategy to generate an equally weighted and market capitalisation daily CBA return series free of these biases, for the period 1990 through to 2002. These daily series also capture important short-run price dynamics that previous studies have ignored.

Keywords: Arbitrage, Convertible bonds, Hedge funds

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1. Introduction

Convertible bond arbitrageurs derive returns from two areas, income and long volatility exposure. Income comes from the coupon paid periodically by the issuer of the convertible bond and from interest on the short stock position. To capture the long volatility exposure, the arbitrageur initiates a dynamic hedging strategy. The hedge is rebalanced as the stock price and/or convertible price move. In this paper we create a simulated convertible bond arbitrage portfolio designed to capture income and volatility, and we also describe the risks associated with combining this portfolio and a long only equity portfolio.

First issued in the United States in the nineteenth century, a simple convertible bond is defined as a corporate bond, paying a fixed coupon, with security, maturing at a certain date with an additional feature allowing it to be converted into a fixed number of the issuer's common stock. According to Calamos (2003) this convertible clause was first added to fixed income investments to increase the attractiveness of investing in rail roads of what was then the emerging economy of the United States. Convertible bonds have grown in complexity and are now issued with features such as put options, call protection, ratchet clauses, step up coupons and floating coupons. Perhaps due to this complexity relatively few individual or institutional investors incorporate convertible into their portfolios. It has been estimated that hedge funds account for seventy percent of the demand for new convertible issues and eighty percent of convertible transactions (see Barkley, 2001; McGee, 2003).

While the overall market for convertible bonds has been growing to an estimated $351.9 billion by the end of December 2003 (BIS, 2004), the hedge fund industry has also been growing at a phenomenal rate. Initially hedge fund investors were interested in large global/macro hedge funds and the majority of the funds went into these strategies. Fung and Hsieh (2000a) estimate that in 1997 twenty seven large hedge funds accounted for at least one third of the assets managed by the industry. However, since the bursting of the dotcom bubble, perhaps due to a reduction in appetite for risk, investors have been increasingly interested in lower volatility non-directional arbitrage strategies. Data from Tremont Advisors and the Barclay Group indicate that convertible arbitrage total market value grew from just $768m in 1994 to $64.9bn in 2004, an astonishing growth rate of 50% on average per annum.

The literature on securities arbitrage dates back more than seventy years. Weinstein (1931) has been credited as being the first to document securities arbitrage. He provides a discussion of how, shortly after the advent of rights, warrants and convertibles in the 1860s arbitrage was born. Although the hedges described by Weinstein lack mathematical precision they appear to have been reasonably successful. Thorp and Kassouf's (1967) seminal work, valuing convertible bonds by dividing them into fixed income and equity option components, was the first to provide a mathematical approach to appraising the relative under or over valuation of convertible securities. The strategies described by Thorp and Kassouf (1967) provide the foundation for the modern day convertible bond arbitrageur.

Academic literature on dynamic trading strategies has generally focused on modelling the relationship between the returns of hedge funds which follow such strategies and the asset markets and contingent claims on those assets in which hedge funds operate (see, for example, Fung and Hsieh, 1997; Liang, 1999; Schneeweis and Spurgin, 1998; Capocci and Hübner, 2004; Agarwal and Naik, 2004). The difficulty with these studies it that the use of hedge fund returns to define the characteristics of a strategy introduces biases as discussed in Fung and Hsieh (2000b). Fung and Hsieh (2001) circumvent these biases by constructing portfolios of look back straddles on various assets which intuitively fit the return characteristics of a trend follower and document a strong correlation between the returns of their portfolios and the returns to trend following commodity trading advisors. Fung and Hsieh (2002) follow a similar methodology to provide evidence of convergence trading in several fixed income strategies. This paper follows Mitchell and Pulvino's (2001) study of merger arbitrage, in attempting to recreate an arbitrageur's portfolio.

Rather than using combinations of derivatives which you would expect to intuitively share the characteristics of a trading strategy's returns we create a convertible arbitrage portfolio by combining financial instruments in a manner akin to that ascribed to practitioners who operate that strategy. The portfolio is created by matching long positions in convertible bonds with short positions in the issuer's equity. This creates a delta neutral hedged convertible bond position that captures income and volatility. We then combine the delta neutral hedged positions into two convertible bond arbitrage portfolios, one equally weighted, the other weighted by market capitalisation of the convertible issuers' equity. To confirm that our portfolios have the characteristics of a convertible arbitrageur we compare the returns of the convertible bond arbitrage portfolio and the returns from two indices of convertible arbitrage hedge funds in a variety of market conditions.

We also examine the relationship between the convertible bond arbitrage portfolios and a traditional buy-and-hold equity portfolio, highlighting the non-linear relationship between daily convertible bond arbitrage returns and daily equity returns. In severe market downturns convertible arbitrage exhibits negative returns. We also find evidence that in severe market upturns the daily returns from our equally weighted convertible bond arbitrage portfolio are negatively related to equities. In effect, the returns to convertible bond arbitrage are akin to writing naked out of the money put and call options. To our knowledge this is the first study to recreate a convertible arbitrage portfolio and also the first to document the negative correlation between daily convertible bond arbitrage and equity market returns in extreme up markets. This negative correlation is explained by the long volatility nature of convertible bond arbitrage. In extreme up markets, implied volatility generally decreases which has a negative effect on portfolio returns. This is an important finding for any investor considering adding a convertible bond arbitrage fund to an existing buy-and-hold long only equity portfolio.

The remainder of the paper is organised as follows. In the next section, we identify some potential explanations for the high returns of convertible bond arbitrage. In Section 3, we describe a typical convertible bond arbitrage position and provide a thorough description of how our portfolio is constructed. A comparison of the returns of the convertible bond arbitrage portfolio with the returns of two convertible arbitrage hedge fund indices and some market factors is given in Section 4. In Section 5, we present the results from examining the relationship between convertible bond arbitrage and a traditional buy-and-hold equity portfolio. Section 6 concludes the paper.

2. Explaining the high returns of convertible bond arbitrage

Analysis of convertible bond arbitrage to date has highlighted the perceived abnormal positive risk adjusted returns that the strategy generates. Ineichen (2000) uses a linear one factor model to document the abnormal returns generated by convertible arbitrage hedge fund indices. More recently, Capocci and Hübner (2004), utilising a linear specification, document convertible arbitrage funds exhibiting significant positive abnormal returns using both single factor and multi factor models. Regardless of the performance measure, model or sample employed convertible bond arbitrage exhibit a significant positive abnormal return (Kazemi and Schneeweis, 2003).

Several studies have documented inefficiencies in the pricing of the convertible bond market. Ammann et al. (2004) find evidence, over an eighteen month period, that twenty one French convertible bonds were underpriced by at least three percent relative to their theoretical values. This result is consistent with King (1986) who found on average that a sample of one hundred and three United States listed convertible bonds were undervalued by almost four percent. There is also evidence that convertible bonds are underpriced at issue. Kang and Lee (1996) identified an abnormal return of one percent from buying convertibles at the issue price and selling at the closing price on the first day of trading. However, this may be due to the difficulty in estimating the value of the option component in unseasoned issues of convertible debt. A further consideration is that, in certain market conditions, investment banks speak to hedge funds managers when pricing new issues of convertible debt to gauge hedge fund demand (Khan, 2002). This suggests that new issues may be priced attractively to ensure their success in a market dominated by non-traditional investors.[1]

Agarwal and Naik (2004) document that convertible bond arbitrage hedge funds exhibit written naked put option like returns, with a stronger correlation between the returns of convertible arbitrage hedge fund indices and equities in down markets. If the returns from convertible bond arbitrage have a non-linear relationship with equities then estimating a traditional one factor model across the entire sample may not capture all of the risk in the strategy. To test for this we subdivide the sample and estimate the market model in a variety of equity market conditions. To correct for the potential downward bias in beta estimation when using daily convertible bond data lags of the excess return on the market portfolio are specified in (1).[2]

$$R_{CB} - R_f = \alpha + \beta' RMRF' + \varepsilon_t \qquad (1)$$

Where $R_{CB} - R_f$ is the excess return on the convertible arbitrage portfolio at time t, β' is a vector of coefficients, $RMRF' = (RMRF_t, RMRF_{t-1} \ldots RMRF_{t-n})$ and $RMRF_t$ is the excess return on the Russell 3000 at time t. Estimating the market model in different market conditions also allows us

[1] In this paper the effects of convertible bond under-pricing at issue is excluded. Positions are included in the portfolio at the closing price of the first day of trading. We acknowledge that this may introduce a negative bias to our portfolio returns relative to hedge fund returns.

[2] Scholes and Williams (1977) and Dimson (1979) amongst others show that betas of securities that trade less (more) frequently than the index used as the market proxy are downward (upward) biased.

to identify what the effect would be of adding a convertible bond arbitrage portfolio to a traditional buy-and-hold equity portfolio (using a broad based equity index as a proxy). Generally, investors are interested in the diversification benefits hedge funds bring to a traditional long only equity portfolio. Of particular interest is the behaviour of these strategies at market extremes.

3. Description of a convertible bond arbitrage position and portfolio construction

Fundamentally, convertible bond arbitrage entails purchasing a convertible bond and selling short the underlying stock creating a delta neutral hedge long volatility position.[3] This is considered the core strategy underlying convertible bond arbitrage. The position is set up so that the arbitrageur can benefit from income and equity volatility. The arbitrageur purchases the convertible bond and takes a short position in the underlying stock at the current delta. The hedge neutralizes equity risk but is exposed to interest rate and volatility risk. Income is captured from the convertible coupon and the interest on the short position in the underlying stock. This income is reduced by the cost of borrowing the underlying stock and any dividends payable to the lender of the underlying stock.

The non-income return comes from the long volatility exposure. The hedge is rebalanced as the stock price and/or convertible price move. Rebalancing will result in adding or subtracting from the short stock position. Transaction costs and the arbitrageur's attitude to risk will affect how quickly the hedge is rebalanced and this can have a large effect on returns. In order for the volatility exposure to generate positive returns the actual volatility over the life of the position must be greater than the implied volatility of the convertible bond at the initial set up of the hedge. If the actual volatility is equal to the implied volatility you would expect little return to be

[3] The arbitrageur may also hedge credit risk using credit derivatives, although these instruments are a relatively recent development. The short equity position partially hedges credit risk, as generally, if an issuer's credit quality declines this will also have a negative effect on the issuer's equity.

earned from the long volatility exposure. If the actual volatility over the life of the position is less than the implied volatility at setup then you would expect the position to have negative non-income returns.[4]

Convertible bond arbitrageurs employ a myriad of other strategies. These include the delta neutral hedge, bull gamma hedge, bear gamma hedge, reverse hedge, call option hedges and convergence hedges.[5] However Calamos (2003) describes the delta neutral hedge as "the bread and butter" hedge of convertible bond arbitrage.

Convertible securities are of various different types including traditional convertible bonds, mandatory convertibles and convertible preferred. This paper focuses exclusively on the traditional convertible bond as this allows us to use a universal hedging strategy across all instruments in the portfolio. We also focus exclusively on convertible bonds listed in the United States between 1990 and 2002. To enable the forecasting of volatility, issuers with equity listed for less than one year were excluded from the sample. Any non-standard convertible bonds and convertible bonds with missing or unreliable data were removed from the sample. The final sample consists of 503 convertible bonds, 380 of which were live at the end of 2002, with 123 dead. The terms of each convertible bond, daily closing prices and the closing prices and dividends of their underlying stocks were included. Convertible bond terms and conditions data were provided by Monis. Closing prices and dividend information came from DataStream and interest rate information came from the United States Federal Reserve Statistical Releases.

A GARCH(1,1) model is employed to estimate volatility as an input in the calculation of the theoretical value of a convertible bond and the corresponding hedge ratio.[6] For each

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[4] It should be noted that the profitability of a long volatility strategy is dependent on the path followed by the stock price and how it is hedged. It is possible to have positive returns from a position even if actual volatility over the life of the position is less than implied volatility at the set up of the position and vice versa.

[5] For a detailed description of the different strategies employed by convertible arbitrageurs see Calamos (2003).

[6] There are a large number of variants in the GARCH family including IGARCH, A-GARCH, NA-GARCH, V-GARCH, Thr.-GARCH, GJR-GARCH, E-GARCH and NGARCH. Empirical evidence on

convertible bond one estimate of future volatility σ_{n+k}^2 is forecast following Bollerslev (1986). Equation (2) sets out how future volatility was estimated from the inclusion date, day *n* to the redemption date, day *k*, using five years of historical closing prices of the underlying stock up to and including day *n-1*, the day before the bond is included in the portfolio.[7]

$$E(\sigma_{n+k}^2) = V_L + (\alpha + \beta)^k (\sigma_n^2 - V_L) \tag{2}$$

$$\sigma_n^2 = \gamma V_L + \alpha u_{n-1}^2 + \beta \sigma_{n-1}^2 \tag{3}$$

subject to

$$\gamma + \alpha + \beta = 1 \tag{4}$$

where σ_n^2 is the estimate of volatility on day *n*, V_L is the long run variance rate, u_{n-1}^2 is the squared percentage change in the market variable between the end of day *n – 2* and the end of day *n-1* and σ_{n-1}^2 is the estimate of volatility on day *n -1*. The parameters α and β are estimated to maximise the objective function (5).

$$\sum_{i=1}^{m} \left(-\ln(v_i) - \frac{u_i^2}{v_i} \right) \tag{5}$$

where v_i is the estimate of the variance rate σ_i^2, for day *i* made on day *i – 1*.

In order to initiate a delta neutral hedge for each convertible bond we need to estimate the delta for each convertible bond on the trading day it enters the portfolio. The delta estimate is then multiplied by the convertible bond's conversion ratio to calculate Δ_{it} the number of shares to be sold short in the underlying stock (the hedge ratio) to initiate the delta neutral hedge. On the following day the new hedge ratio, Δ_{it+1}, is calculated, and if $\Delta_{it+1} > \Delta_{it}$ then $\Delta_{it+1} - \Delta_{it}$ shares

their relative performance is mixed (see Poon and Granger (2003) for a comprehensive review). As none of the variants consistently outperforms, GARCH(1,1) is used in this study.

[7] For some equities in the sample five years of historic data was unavailable. In this situation volatility was forecast using available data, restricted to a minimum of one year. Only equities with a minimum of one year of historical data were included in the original sample.

are sold, or if $\Delta_{it+1} < \Delta_{it}$, then Δ_{it} - Δ_{it+1} shares are purchased maintaining the delta neutral hedge.[8]

Daily returns were calculated for each position on each trading day up to and including the day the position is closed out. A position is closed out on the day the convertible bond is delisted from the exchange. Convertible bonds may be delisted for several reasons. The company may be bankrupt, the convertible may have expired or the convertible may have been fully called by the issuer.

The returns for a position *i* on day *t* are calculated as follows.

$$R_{it} = \frac{P_{it}^{CB} - P_{it-1}^{CB} + C_{it} - \Delta_{it-1}(P_{it}^{U} - P_{it-1}^{U} + D_{it}) + r_{t-1}S_{i,t-1}}{P_{it-1}^{CB} + \Delta_{it-1}P_{it-1}^{U}} \qquad (6)$$

Where R_{it} is the return on position *i* at time *t*, P_{it}^{CB} is the convertible bond closing price at time *t*, P_{it}^{U} is the underlying equity closing price at time *t*, C_{it} is the coupon payable at time *t*, D_{it} is the dividend payable at time *t*, Δ_{it-1} is the delta neutral hedge ratio for position *i* at time *t – 1* and $r_{t-1}S_{i,t-1}$ is the interest on the short proceeds from the sale of the shares. Daily returns are then compounded to produce a position value index for each hedged convertible bond over the entire sample period.

A summary of the individual convertible bond arbitrage return series is presented in Table 1. The majority of new positions were added in the years 1990, 2001 and 2002.[9] The average position duration was 11.6 years, and the average position return was 70.1%, 4.7% per annum. The maximum return on an individual position was 460.7% and the minimum position return was -95.6%. 235 new positions were added in 2001, with average position duration of 1.6

[8] As discussed earlier, due to transaction costs, an arbitrageur would not normally rebalance each hedge daily. However to avoid making ad hoc decisions on the timing of the hedge, we rebalance the portfolio daily and also exclude transaction costs.
[9] In 1990, 66 new positions were added, of which 55 were listed prior to 1990.

years and average position return of 6% per annum. 1997, 1998 and 1999 are the years when the fewest new positions were added to the portfolio. In 1997 and 1998 one new position was added in each year, and in 1999 only four new positions were added. The lowest returns were generated by positions added in 1999 and 2000, with average annual returns of -2.25% and -2%, respectively. The closing out of positions is spread reasonably evenly over the sample period, with the exception of 2002 where the majority of positions were closed out when the portfolio is liquidated at 31st December 2002.

Two convertible bond arbitrage portfolios are calculated – an equally weighted and market capitalisation weighted – using a similar methodology to CSFB Tremount Hedge Fund Index (2002). As the market capitalisation portfolio has a bigger weighting of large convertible bond issues it should be more liquid and be of a higher credit quality, thus intuitively one would expect fewer arbitrage opportunities.

The value of the two convertible bond arbitrage portfolios on a particular date is given by the formula.

$$V_t = \frac{\sum_{i=1}^{i=N_t} W_{it} PV_{it}}{F_t} \tag{7}$$

where V_t is the portfolio value on day *t*, W_{it} is the weighting of position *i* on day *t*, PV_{it} is the value of position *i* on day *t*, F_t is the divisor on day *t* and N_t is the total number of position on day *t*. For the equally weighted portfolio W_{it} is set equal to one for each live hedged position. For the market capitalization index the weighting for position *j* is calculated as follows.

$$W_{jt} = \frac{MC_{jt}}{\sum_{i=1}^{i=N_t} MC_{it}} \tag{8}$$

where W_{jt} is the weighting for position *j* at time *t*, N_t is the total number of position on day *t* and MC_{it} is the market capitalization of issuer *i* at time *t*. To avoid daily rebalancing of the market capitalization weighted portfolio the market capitalizations on the individual positions are updated at the end of each calendar month. However, if a new position is added or an old position is removed during a calendar month then the portfolio is rebalanced.

On the inception date of both portfolios, the value of the divisor is set so that the portfolio value is equal to 100. Subsequently the portfolio divisor is adjusted to account for changes in the constituents or weightings of the constituent positions in the portfolio. Following a portfolio change the divisor is adjusted such that equation (9) is satisfied.

$$\frac{\sum_{i=1}^{i=N_t} W_{ib} PV_i}{F_b} = \frac{\sum_{i=1}^{i=N_t} W_{ia} PV_i}{F_a} \tag{9}$$

Where PV_i is the value of position *i* on the day of the adjustment, W_{ib} is the weighting of position *i* before the adjustment, W_{ib} is the weighting of position *i* after the adjustment, F_b is the divisor before the adjustment and F_a is the divisor after the adjustment.

Thus the post adjustment index factor F_a is then calculated as follows.

$$F_a = \frac{F_b x \sum_{i=1}^{i=N_t} W_{ib} PV_i}{\sum_{i=1}^{i=N_t} W_{ia} PV_i} \tag{10}$$

As the margins on the strategy are small relative to the nominal value of the positions convertible bond arbitrageurs usually employ leverage. Calamos (2003) and Ineichen (2000) estimate that for an individual convertible arbitrage hedge fund this leverage may vary from one to ten times equity. However, the level of leverage in a well run portfolio is not static and varies depending on the opportunity set and risk climate. Khan (2002) estimates that in mid 2002 convertible arbitrage hedge funds were at an average leverage level of 2.5 to 3.5 times equity, with estimates approximating 5 to 7 times equity in late 2001. In the case of our simulated portfolios we apply leverage of one times equity to both our portfolios as this produces portfolios with a similar average return to the HFRI Convertible Arbitrage Index and the CSFB Tremont Convertible Arbitrage Index.[10]

Table 2 presents annual return series for the equally weighted and market capitalization weighted convertible bond arbitrage portfolios, the CSFB Tremont Convertible Arbitrage Index, the HFRI Convertible Arbitrage Index, the Russell 3000 Index, the Merrill Lynch Convertible Securities Index and the risk-free rate. The two highest returning years for the convertible bond arbitrage portfolios, 1991 and 1995 correspond with the two highest returning years for the Russell 3000, the Merrill Lynch convertibles index and the HFRI hedge fund index. In 1991 the equally weighted index returned +17.2%, the market capitalization weighted index returned 17.43% and the HFRI index returned +16.2%. However, the convertible bond arbitrage strategy was outperformed by a simple buy-and-hold equity (+26.4%) or convertible bond (+21.6%) strategy. 1995 produced strong returns with the equally weighted portfolio +23.2%, the market capitalization weighted portfolio +16.9%, the HFRI index +18.1% and the CSFB Tremont hedge fund index +15.3%. Again the strategy was outperformed by a simple buy-and-hold equity strategy (+29%) but outperformed the general convertible securities market.

The lowest returns for the equally weighted convertible bond arbitrage portfolio occur in 1990 and 1994, which also corresponds with negative returning years for the Russell 3000 and Merrill Lynch convertible securities index.[11] The HFRI index had a below average return of +2.14% in 1990 and had its lowest return of -3.8% in 1994. The CSFB Tremont index does not date back to 1990 but in 1994 it had also had its lowest return of -8.4%. The two lowest returning

[10] To ensure the level of leverage is not an important factor in our results we apply alternative levels of leverage to the portfolio from 0 to 5 times. Results were not materially different than for the 1 times equity portfolio and are available from the authors.
[11] Ineichen (2000) notes that 1994 was not a good year for convertible arbitrage characterised by rising US interest rates.

years for the market capitalization weighted index were 1990 and 1992. In 1998 the CSFB Tremont index also had a negative return of -4.5%, however none of the other indices or portfolios had negative returns.

More recently in 2000, 2001 and 2002, after the bursting of the dotcom bubble, both of the convertible bond arbitrage portfolios (returning an average 7.3% for the equally weighted and 5.52% for the market capitalization weighted), the HFRI Convertible Arbitrage Index and the CSFB Tremont Convertible Arbitrage Hedge Fund Index have performed well. During this period the Russell 3000 and the Merrill Lynch Convertible Securities Index had an average annual return of -16.1% and -10.26%. This performance has demonstrated the diversification benefits of the convertible bond arbitrage strategy. However, it should be noted that the sample period has been characterized by rapidly falling interest rates and an increase in convertible issuance.

Looking at the distribution of the monthly returns, both the equal weighted and the market capitalization weighted portfolios display negative skewness of -1.23 and -0.77, respectively. The CSFB Tremont index and the HFRI index also display negative skewness. This is consistent with other studies (see Agarwal and Naik, 2004; Kat and Lu, 2002). The monthly returns from the equal weighted and the market capitalization weighted portfolios also display positive kurtosis. Similar to Kat and Lu (2002), we find that the estimates of kurtosis appear to be high relative to the two hedge fund indices.

4. Validation of Convertible Arbitrage Portfolios

A comparison of the convertible bond arbitrage portfolios with two market standard hedge fund indices and the overall market portfolio for a variety of market conditions provides a starting point in validating the robustness of the two generated portfolios. Furthermore, as highlighted earlier, investors have become interested in lower volatility non-directional arbitrage strategies because of the diversification benefits they bring to their portfolios in a low-return equity environment. A comparison across market conditions provides evidence of this diversification benefit dependence to market swings.

Table 3 presents the correlation coefficients between the monthly returns on the equally weighted convertible bond arbitrage portfolio (Equal), the market capitalization weighted portfolio (MC), the CSFB Tremont Convertible Arbitrage Index (CSFB), the HFRI Convertible Arbitrage Index (HFRI), the Russell 3000, the Merrill Lynch Convertible Securities Index (MLCS) and the VIX Index (VIX)[12]. As the CSFB data is unavailable prior to 1994 the correlation coefficients cover returns from January 1994 to December 2002.[13]

The Equal, MC, CSFB and HFRI indices are all positively correlated with the MLCS index. With the exception of the CSFB index they are also all positively correlated with equities. The Equal is positively correlated with the MC, CSFB and HFRI indices over the entire sample period. Surprisingly, the MC is not correlated with the CSFB index, although it is positively correlated with the HFRI index. Monthly returns on the VIX are negatively correlated with both the Equal and MC portfolios indicating that they are both negatively correlated with implied volatility. Neither of the hedge fund indices has any correlation with the VIX. This is surprising as convertible bond arbitrage is a long volatility strategy.

Next we ranked our sample of 108 monthly returns by equity market return and subdivided the sample into four equal sized sub-samples of 27 months. State 1, which is presented in Panel A of Table 4, covers the correlations between convertible bond arbitrage returns and market factors in the 27 lowest equity market returns (ranging from -16.8% to -2.6%). The Equal portfolio and the two hedge fund indices are positively correlated with the MLCS index in this sub-sample. The Equal portfolio is positively correlated with the two hedge fund indices and the three are all negatively correlated with the VIX. In this sub-sample the MC

[12] The VIX index is an equity volatility index calculated by the Chicago Board Option Exchange. It is calculated by taking a weighted average of the implied volatilities of 8 30-day call and put options to provide an estimate of equity market volatility.

[13] Correlation coefficients were estimated for the entire sample period 1990 to 2002 for all variables excluding the CSFB data. There was no change in the sign or significance of any of the coefficients.

portfolio is not correlated with any of the other return series or market factors. The Equal portfolio shares more characteristics with the hedge fund indices, than the MC portfolio does.

Panel B of Table 4 looks at the correlations between convertible bond arbitrage returns and market factors in the 27 next lowest equity market returns (ranging from -2.2% to +1.3%). None of our convertible arbitrage portfolios or indices has any correlation with equities in this sub-sample. Both the CSFB and HFRI indices are correlated with the MLCS and VIX indices. The Equal portfolio is positively correlated with the MC portfolio and also the two hedge fund indices are positively correlated.

Panel C of Table 4 looks at the correlations between convertible arbitrage returns and market factors in the 27 next lowest equity market returns (ranging from +1.4% to +3.9%). The two hedge fund indices are positively correlated with the MLCS index and each other. The MC portfolio is also correlated with the HFRI index.

The final sub-sample, looking at the correlations between convertible arbitrage returns and market factors in the 27 highest equity market returns (ranging from +4.0% to 7.6%) is presented in Panel D of Table 4. The Equal portfolio is positively correlated with the MC portfolio and the HFRI index. Both the CSFB and HFRI indices are positively correlated with the VIX in this sample period, which is negatively related to equity market returns. This indicates that in periods of high equity market returns, the change in volatility is negative and hedge fund returns are affected. Neither of these factors affects our two portfolios of convertible bond arbitrage returns.

Based on the evidence presented so far, the two hedge fund indices appear to share many of the characteristics of our convertible bond arbitrage portfolios. Over the entire sample period they are all positively correlated, and when the sample is subdivided they share similar characteristics. Perhaps the hedge fund indices share more characteristics with the Equal portfolio than the MC portfolio particularly in market downturns. This indicates that convertible arbitrageurs do not weight positions in their portfolio according to the size of the issuer, thus is possibly due to greater arbitrage opportunities in the relatively smaller issues. It is also interesting to note that convertible arbitrage is positively correlated with the underlying convertible securities market in downturns and there are traces of a negative relationship, due to decreases in volatility, with equity market returns in market upturns.

5. Results of the market model regressions

The results so far indicates that the relationship between convertible arbitrage and equity market returns is non-linear. As discussed previously we are not the first authors to come to this conclusion. However, studies to date have been restricted to analyzing relatively low frequency monthly returns data. Estimating the market model using daily data allows us to examine the short run dynamics in the relationship between a buy-and-hold equity portfolio (using the Russell 3000 as a proxy) and convertible bond arbitrage. This is particularly important for an investor considering combining a convertible bond arbitrage strategy with a traditional buy-and-hold equity portfolio. We initially estimate the model using the entire sample period and then subdivide according to ranked equity market returns. To correct for potential bias in beta estimation when using high frequency data we specify lagged and contemporaneous observations of the return on the Russell 3000 in excess of the risk free rate of interest in (11) as explanatory variables.[14] The estimated beta coefficients are then summed. p-values from an F-test of the hypothesis that the summed beta coefficients are equal to zero are then calculated.

$$R_{CB} - R_f = \alpha + \beta_{0,t} RMRF_t + \beta_{1,t} RMRF_{t-1} + \beta_{2,t} RMRF_{t-2} + \beta_{3,t} RMRF_{t-3} + \beta_{4,t} RMRF_{t-4} + \varepsilon_t \qquad (11)$$

Where R_{CB} is the daily return on the convertible bond arbitrage portfolio, $RMRF_t$ is the daily return on the Russell 3000 stock index in excess of R_f at time t, and R_f is the daily yield on a three month treasury bill.

[14] Results are reported in Tables 5 and 6 include four time period lags of the excess market return as the coefficients on lags beyond four time periods were not statistically significant in any of the sample periods.

Table 5 reports the results from modelling the returns from the equal weighted convertible arbitrage portfolio and Table 6 reports the results from modelling the returns from the market capitalization weighted convertible arbitrage portfolio. Both tables are organized as follows: Panel A covers the entire sample, Panel B reports the results when restricting the sample to those observations when the equity market (*RMRF*) is within one standard deviation of the mean, Panel C reports the results when the sample is restricted to those observations at least one standard deviation less than the mean, Panel D reports the results when the sample is restricted to more than one standard deviation greater than the mean, Panel E restricts the sample to at least two standard deviations less than the mean and Panel F restricts the sample to more than two standard deviations greater than the mean. The findings for the two convertible arbitrage portfolios – the market capitalization and equally weighted portfolios are very similar.

Over the entire sample period (Table 5, Panel A), the market model indicates that the convertible bond arbitrage portfolio has a positive equity market beta of 0.15 and a significant alpha of 0.0002. This indicates a positive abnormal return, based on the market model, of approximately 5% per annum. When the equity market is close to its mean (Panel B), the beta is approximately 0.15 and alpha is a little lower at 0.0001.[15] The beta (and adjusted R^2) increases when the equity market falls significantly below the mean (see Table 5, Panels C and E). For periods when the equity market is significantly above its mean, the beta coefficient is lower, with little relationship between convertible bond arbitrage and the equity markets.

To provide a closer examination of non-linearity in the relationship between convertible bond arbitrage and the equity portfolio, we limit the sample to those days when the equity market (*RMRF*) is more than two and a half standard deviations form its mean. When (11) was estimated for this sample period none of the lags beyond *t-1* were significant, so the results from estimating (12) are presented in Table 7.

[15] Note that Panel B represents some 68.3% of the total trading days of the sample.

$$R_{CB} - R_f = \alpha + \beta_{0,t}\, RMRF_t + \beta_{1,t} RMRF_{t-1} + \varepsilon_t \qquad (12)$$

This sample period represents a relatively infrequent seven trading days per year but from an investors perspective these may be the most important. Panel A looks at those days when the equity market is at least two and a half standard deviations less than its mean. The explanatory power of the regression is higher than for the entire sample though the market beta is lower at 0.13 than for the entire sample period (similar outcome to that reported in Table 5, Panels C and E). When the equity market is far above its mean the results are striking. The explanatory power of the regression is high with an adjusted R^2 of 14.4%, and the market beta is -0.23, significant at the one percent level, providing further evidence of the negative relationship between convertible bond arbitrage and equity returns in extremely positive equity markets (see also Table 5, Panel F). The results for the market capitalization portfolio, see Table 8, are very similar although the negative beta coefficient is not significant at any statistically acceptable significance level.

6. Conclusion

In this paper we simulated a convertible bond arbitrage portfolio providing some useful evidence on the characteristics of this dynamic trading strategy. We combined long positions in convertible bonds with short positions in the common stock of the issuer to create individual delta neutral hedged convertible bonds in a manner consistent with an arbitrageur capturing income. These individual positions were then dynamically hedged on a daily basis to capture volatility and maintain a delta neutral hedge. We then combined these positions into two convertible bond arbitrage portfolios and demonstrated that the monthly returns of our convertible bond arbitrage portfolio were positively correlated with two indices of convertible arbitrage hedge funds.

Across the entire sample period our two portfolios had market betas of between 0.15 and 0.24. Assuming the market model is correctly specified our convertible arbitrage portfolios appear to generate abnormal positive returns in excess of 3% per annum. However, we also demonstrate that the relationship between daily convertible bond arbitrage returns and a traditional buy-and-hold equity portfolio is non-linear. In normal market conditions, when the equity market is close to its mean (within one standard deviation), the two convertible bond arbitrage portfolios have market betas of between 0.15 and 0.26. When we look at extreme negative equity market returns (at least two standard deviations below the mean) these betas are 0.17 and 0.30 for the equal weighted portfolio and the market capitalization weighted portfolio, respectively. This finding suggests that there is a small increase in equity market risk as equity markets weaken.

Perhaps most interesting is our finding that in extreme positive equity markets a convertible bond arbitrage portfolio will exhibit a negative relationship with a traditional buy-and-hold portfolio. This is an important factor for any investor considering the addition of a convertible bond arbitrage portfolio or fund to a traditional long only equity portfolio and we hypothesize that it is due to the drop in implied volatility associated with such market conditions.

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Table 1

Sample summary

This table presents a summary of the individual convertible bond hedges constructed in this paper. Position duration is measured as the number of trading days from the addition of the hedged convertible position to the portfolio to the day the position is closed out. Max position return is the maximum cumulated return of a position from the date of inclusion to the date the position is closed out. Min position return is the minimum cumulated return earned by a position from the date of inclusion to the date the position is closed out. Average position return is the average cumulated return of a position from the date of inclusion to the date the position is closed out. Number of positions closed out is the number of positions which have been closed during a year.

Year	Number of New Positions	Average Position Duration (Yrs)	Max Position Return %	Min Position Return %	Average Position Return %	Number of Positions Closed out
1990	66	11.6	460.7	(95.6)	70.1	
1991	9	9.8	127.5	7.9	51.6	
1992	11	10.1	154.9	(59.5)	20.5	1
1993	10	9.7	88.1	1.26	39.6	2
1994	27	8.3	178	(99.1)	51.4	2
1995	33	6.8	453	(85.5)	46.7	2
1996	10	6.9	194.4	2.9	52.5	14
1997	1	5.4	22.2	22.2	22.2	12
1998	1	5	1	1	1	11
1999	4	3.5	24.1	(69.6)	(7.7)	8
2000	15	2.3	80.7	(85.5)	(4.6)	4
2001	235	1.6	344.3	(96.9)	9.81	16
2002	81	0.27	58.7	(29.6)	0.9	431
Complete Sample	503					503

Table 2
Annual convertible bond arbitrage return series

This table presents the annual return series for the equally weighted and market capitalization weighted convertible bond arbitrage portfolios, the CSFB Tremont Convertible Arbitrage index, the HFRI Convertible Arbitrage Index, the Russell 3000 Index, the Merrill Lynch Convertible Securities Index and the risk-free rate. The CSFB Tremont Convertible Arbitrage Index is an index of convertible arbitrage hedge funds weighted by assets under management. The HFRI Convertible Arbitrage Index is an equally weighted index of convertible arbitrage hedge funds. The Russell 3000 Index is a broad based index of United States equities and the Merrill Lynch Convertible Securities Index is a broad based index of convertible securities. The risk free rate of interest is represented by the yield on a three-month treasury bill. All annual returns are obtained by compounding monthly returns. Annual standard deviations are obtained by multiplying the standard deviation of monthly returns by $\sqrt{12}$.

Year	Equally Weighted (%)	Mkt Cap Weighted (%)	CSFB Tremont Index (%)	HFRI Index (%)	Russell 3000 (%)	Merrill Lynch CB Index (%)	VIX (%)	Risk Free Rate (%)
1990	-15.83	0.63		2.14	-9.13	-14.43	-17.98	7.75
1991	18.42	21.08		16.21	26.36	21.63	17.82	5.54
1992	16.09	8.82		15.14	6.38	14.70	12.90	3.51
1993	6.51	6.13		14.17	7.82	12.67	17.17	3.07
1994	4.17	2.72	-8.41	-3.80	-2.51	-12.33	22.66	4.37
1995	25.64	21.12	15.33	18.11	28.95	17.00	13.90	5.62
1996	10.36	8.21	16.44	13.59	17.55	8.63	29.69	5.15
1997	13.73	15.00	13.52	11.98	25.83	13.12	2.48	5.20
1998	3.57	11.80	-4.51	7.48	20.15	3.94	83.65	4.91
1999	6.27	6.46	14.88	13.47	17.75	33.17	-1.77	4.78
2000	6.21	7.65	22.82	13.54	-8.90	-15.51	-9.15	6.00
2001	8.80	4.88	13.61	12.55	-13.49	-7.13	-7.99	3.48
2002	6.13	2.97	2.32	8.68	-25.89	-8.15	-21.17	1.64
Mean	8.47 (9.43)	9.30 (9.20)	9.74	11.02 (10.62)	6.99 (6.61)	5.18 (3.64)	0.79 (0.86)	4.69 (4.57)
Standard Deviation	6.04 (4.48)	7.03 (5.91)	4.88	3.37 (3.56)	15.41 (16.37)	12.51 (13.52)	80.47 (86.47)	5.30 (4.56)
Skew	-1.22	0.13	-1.69	-1.39	-0.73	-0.29	0.37	-0.11
Kurtosis	8.49	2.08	4.38	3.35	1.00	1.92	0.99	0.85

*To aid comparison with the CSFB Tremont Convertible Arbitrage Index figures in parenthesis are the average annual rate of return and annual standard deviation of returns from January 1994 to December 2002.

Table 3
Correlation between monthly convertible bond arbitrage returns and market factors

This table presents correlation coefficients for monthly returns on the equally weighted (Equal Portfolio) and market capitalization weighted (MC Portfolio) convertible bond arbitrage portfolios, the CSFB Tremont Convertible Arbitrage Index, the HFRI Convertible Arbitrage Index, and market factor returns. The Russell 3000 is a broad based index of US equities. The Merrill Lynch Convertible Securities Index is an index of US convertible securities and the VIX is an equity volatility index calculated by the Chicago Board Option Exchange. It is calculated by taking a weighted average of the implied volatilities of 8 30-day call and put options to provide an estimate of equity market volatility.

	Russell 3000	ML Convertible Securities	VIX	Equal Portfolio	CSFB Tremont Convertible	MC Portfolio	HFRI Convertible
Russell 3000	1.00						
ML Convertible Securities	0.73***	1.00					
VIX	-0.64***	-0.42***	1.00				
Equal Portfolio	0.50***	0.51***	-0.29***	1.00			
CSFB Tremont Convertible	0.17*	0.29***	0.04	0.33***	1.00		
MC Portfolio	0.58***	0.48***	-0.32***	0.68***	0.24**	1.00	
HFRI Convertible	0.37***	0.49***	-0.13	0.49***	0.80***	0.42***	1.00

*, **, *** indicate coefficient is significantly different from zero at the .10, .05 and .01 levels respectively.

Table 4
Correlation between monthly convertible bond arbitrage returns and market factors in different states of the economy

This table presents correlation coefficients for monthly returns on the equally weighted (Equal Portfolio) and market capitalization weighted (MC Portfolio) convertible bond arbitrage portfolios, the CSFB Tremont Convertible Arbitrage Index, the HFRI Convertible Arbitrage Index, and market factor returns in different states of the economy. The sample was ranked according to equity market returns and then divided into 4 equal sized groups with lowest returns in state 1, next lowest returns in state 2, highest returns in state 4 and next highest returns in state 3. Panels A to D represent correlations coefficients between CBA returns and market factors in each state, 1-4.

Panel A: State 1 returns

	Russell 3000	ML Convertible Securities	VIX	Equal Portfolio	CSFB Tremont Convertible	MC Portfolio	HFRI Convertible
Russell 3000	1.00						
ML Convertible Securities	0.56***	1.00					
VIX	-0.55***	-0.40**	1.00				
Equal Portfolio	0.15	0.47**	-0.35*	1.00			
CSFB Tremont Convertible	0.57***	0.44**	-0.73***	0.59***	1.00		
MC Portfolio	0.29	0.54***	-0.39**	0.41**	0.15	1.00	
HFRI Convertible	0.40**	0.41**	-0.65***	0.62***	0.90***	0.23	1.00

*, **, *** indicate coefficient is significantly different from zero at the .10, .05 and .01 levels respectively.

Table 4 (continued)

Panel B: State 2 returns

	Russell 3000	ML Convertible Securities	VIX	Equal Portfolio	CSFB Tremont Convertible	MC Portfolio	HFRI Convertible
Russell 3000	1.00						
ML Convertible Securities	0.54***	1.00					
VIX	-0.42**	-0.05	1.00				
Equal Portfolio	0.08	0.06	-0.13	1.00			
CSFB Tremont Convertible	0.03	0.40**	0.32	0.06	1.00		
MC Portfolio	0.06	0.11	0.16	0.44**	0.14	1.00	
HFRI Convertible	-0.13	0.40**	0.45*	0.11	0.79***	0.16	1.00

Panel C: State 3 returns

	Russell 3000	ML Convertible Securities	VIX	Equal Portfolio	CSFB Tremont Convertible	MC Portfolio	HFRI Convertible
Russell 3000	1.00						
ML Convertible Securities	0.44**	1.00					
VIX	-0.09	0.05	1.00				
Equal Portfolio	0.30	0.20	0.02	1.00			
CSFB Tremont Convertible	0.13	0.44**	0.26	0.26	1.00		
MC Portfolio	0.13	0.10	-0.24	0.67***	0.28	1.00	
HFRI Convertible	0.31	0.57***	0.13	0.36*	0.82***	0.36*	1.00

*, **, *** indicate coefficient is significantly different from zero at the .10, .05 and .01 levels respectively.

Table 4 (continued)

Panel D: State 4 returns

	Russell 3000	ML Convertible Securities	VIX	Equal Portfolio	CSFB Tremont Convertible	MC Portfolio	HFRI Convertible
Russell 3000	1.00						
ML Convertible Securities	0.13	1.00					
VIX	-0.34*	0.07	1.00				
Equal Portfolio	-0.23	0.16	0.23	1.00			
CSFB Tremont Convertible	-0.12	0.10	0.51***	0.39**	1.00		
MC Portfolio	0.02	-0.05	0.37*	0.59***	0.32	1.00	
HFRI Convertible	-0.13	0.22	0.47**	0.44**	0.80***	0.48**	1.00

*, **, *** indicate coefficient is significantly different from zero at the .10, .05 and .01 levels respectively.

Table 5
Regression of daily equally weighted convertible bond arbitrage returns

This table presents results from the following regression of convertible bond arbitrage returns on contemporaneous and lagged excess market returns.

$$R_{CB} - R_f = \alpha + \beta_{0,t}\, RMRF_t + \beta_{1,t} RMRF_{t-1} + \beta_{2,t}\, RMRF_{t-2} + \beta_{3,t}\, RMRF_{t-3} + \beta_{4,t}\, RMRF_{t-4} + \varepsilon_t$$

where R_{CB} is the daily return on the equal weighted convertible bond arbitrage portfolio, $RMRF_t$ is the daily return on the Russell 3000 stock index in excess of R_f at time t, and R_f is the daily yield on a three month treasury bill. Panel A of the table presents results for the entire sample period. Panel B presents results after restricting the sample to those days with excess market returns within one standard deviation of their mean. Panel C presents results after restricting the sample to days with excess market returns at least one standard deviation less than the mean. Panel D presents results after restricting the sample to those days with excess market returns more than one standard deviation greater than the mean. Panel E presents results after restricting the sample to days with excess market returns at least two standard deviations less than the mean. Panel F presents results after restricting the sample to days with excess market returns more than two standard deviations greater than the mean. $\beta_{RMRF} = (\beta_{0,t} + \beta_{1,t} + \beta_{2,t} + \beta_{3,t} + \beta_{4,t})$. P-values from the F-test that $\alpha = 0$ and $(\beta_{0,t} + \beta_{1,t} + \beta_{2,t} + \beta_{3,t} + \beta_{4,t}) = 0$ are in parenthesis

Dependent Variable	α	β_{RMRF}	Adj. R^2 (%)	Sample Size
Panel A: Entire Sample				
$R_{CB} - R_f$	0.0002	0.1529	9.1%	3387
	(0.00)	(0.00)		
Panel B: Market Return - R_f (within 1 S.D. of the mean)				
$R_{CB} - R_f$	0.0001	0.1550	5.3%	2602
	(0.06)	(0.00)		
Panel C: Market Return - R_f (1 S.D. less than the mean)				
$R_{CB} - R_f$	0.0005	0.1649	10.6%	397
	(0.21)	(0.00)		
Panel D: Market Return - R_f (1 S.D. greater than the mean)				
$R_{CB} - R_f$	0.0006	0.1203	8.3%	389
	(0.35)	(0.01)		
Panel E: Market Return - R_f (2 S.D. less than the mean)				
$R_{CB} - R_f$	0.0015	0.1771	19.8%	108
	(0.03)	(0.00)		
Panel F: Market Return - R_f (2 S.D. greater than the mean)				
$R_{CB} - R_f$	0.0047	-0.0730	7.8%	85
	(0.01)	(0.27)		

Table 6
Regression of daily market capitalization weighted convertible bond arbitrage returns

This table presents results from the following regression of convertible bond arbitrage returns on contemporaneous and lagged excess market returns.

$$R_{CB} - R_f = \alpha + \beta_{0,t}\, RMRF_t + \beta_{1,t}\, RMRF_{t-1} + \beta_{2,t}\, RMRF_{t-2} + \beta_{3,t}\, RMRF_{t-3} + \beta_{4,t}\, RMRF_{t-4} + \varepsilon_t$$

where R_{CB} is the daily return on the market capitalisation weighted convertible bond arbitrage portfolio, $RMRF_t$ is the daily return on the Russell 3000 stock index in excess of R_f at time t, and R_f is the daily yield on a three month treasury bill. Panel A of the table presents results for the entire sample period. Panel B presents results after restricting the sample to those days with excess market returns within one standard deviation of their mean. Panel C presents results after restricting the sample to days with excess market returns at least one standard deviation less than the mean. Panel D presents results after restricting the sample to those days with excess market returns more than one standard deviation greater than the mean. Panel E presents results after restricting the sample to days with excess market returns at least two standard deviations less than the mean. Panel F presents results after restricting the sample to days with excess market returns more than two standard deviations greater than the mean. $\beta_{RMRF} = (\beta_{0,t} + \beta_{1,t} + \beta_{2,t} + \beta_{3,t} + \beta_{4,t})$. *P*-values from the *F*-test that $\alpha = 0$ and $(\beta_{0,t} + \beta_{1,t} + \beta_{2,t} + \beta_{3,t} + \beta_{4,t}) = 0$ are in parenthesis

Dependent Variable	α	β_{RMRF}	Adj. R^2	Sample Size
Panel A: Entire Sample				
$R_{CB} - R_f$	0.0001	0.2477	12.5%	3387
	(0.02)	(0.00)		
Panel B: Market Return - R_f (within 1 S.D. of the mean)				
$R_{CB} - R_f$	0.0001	0.2583	6.9%	2602
	(0.36)	(0.00)		
Panel C: Market Return - R_f (1 S.D. less than the mean)				
$R_{CB} - R_f$	0.0011	0.2846	13.9%	397
	(0.10)	(0.00)		
Panel D: Market Return - R_f (1 S.D. greater than the mean)				
$R_{CB} - R_f$	0.0000	0.2007	6.5%	389
	(0.99)	(0.00)		
Panel E: Market Return - R_f (2 S.D. less than the mean)				
$R_{CB} - R_f$	0.0025	0.2985	20.5%	108
	(0.10)	(0.00)		
Panel F: Market Return - R_f (2 S.D. greater than the mean)				
$R_{CB} - R_f$	0.0037	0.0214	-2.2%	85
	(0.20)	(0.87)		

Table 7

Regression of daily equally weighted convertible bond arbitrage returns at market extremes

This table presents results from the following regression of convertible bond arbitrage returns on contemporaneous and lagged excess market returns.

$$R_{CB} - R_f = \alpha + \beta_{0.t}\, RMRF_t + \beta_{1,t}\, RMRF_{t-1} + \varepsilon_t$$

where R_{CB} is the daily return on the equal weighted convertible bond arbitrage portfolio, $RMRF_t$ is the daily return on the Russell 3000 stock index in excess of R_f at time t, and R_f is the daily yield on a three month treasury bill. Panel A of the table presents results after restricting the sample to those days with excess market returns at least two and a half standard deviations less than their mean. Panel B presents results after restricting the sample to those days with excess market returns at least two and a half standard deviations greater than their mean. $\beta_{RMRF} = (\beta_t + \beta_{t-1})$. *P*-values from the *F*-test that $\alpha = 0$ and $(\beta_{0,t} + \beta_{1,t}) = 0$ are in parenthesis

Dependent Variable	α	β_{RMRF}	Adj. R^2	Sample Size
Panel A: Market Return - R_f (2.5 S.D. less than the mean)				
$R_{CB} - R_f$	0.0019	0.1260	15.3%	44
	(0.05)	(0.00)		
Panel B: Market Return - R_f (2.5 S.D. greater than the mean)				
$R_{CB} - R_f$	0.0132	-0.2316	14.4%	42
	(0.00)	(0.01)		

Table 8
Regression of daily market capitalization convertible bond arbitrage returns at market extremes

This table presents results from the following regression of convertible bond arbitrage returns on contemporaneous and lagged excess market returns.

$$R_{CB} - R_f = \alpha + \beta_{0,t}\, RMRF_t + \beta_{1,t}\, RMRF_{t-1} + \varepsilon_t$$

where R_{CB} is the daily return on the market capitalization weighted convertible bond arbitrage portfolio, $RMRF_t$ is the daily return on the Russell 3000 stock index in excess of R_f at time t, and R_f is the daily yield on a three month treasury bill. Panel A of the table presents results after restricting the sample to those days with excess market returns at least two and a half standard deviations less than their mean. Panel B presents results after restricting the sample to those days with excess market returns at least two and a half standard deviations greater than their mean. $\beta_{RMRF} = (\beta_{0,t} + \beta_{1,t})$. P-values from the F-test that $\alpha = 0$ and $(\beta_{0,t} + \beta_{1,t}) = 0$ are in parenthesis

Dependent Variable	α	β_{RMRF}	Adj. R^2	Sample Size
Panel A: Market Return - R_f (2.5 S.D. less than the mean)				
$R_{CB} - R_f$	0.0052	0.2975	34.2%	44
	(0.00)	(0.00)		
Panel B: Market Return - R_f (2.5 S.D. greater than the mean)				
$R_{CB} - R_f$	0.0110	-0.1505	-2.2%	42
	(0.04)	(0.34)		