Center for International Securities and Derivatives Markets

Capital Structure Arbitrage: An Empirical Investigation using Stocks and High Yield Bonds

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Capital Structure Arbitrage

Introduction

Capital structure arbitrage is one of the most recent hedge fund strategies that is rapidly gaining popularity amongst traders. It has been gaining in popularity since 2000 and aims to exploit the pricing inefficiency that exists in the capital structure of the same firm. For example, one could go long the high yield bond and short the stock of a company to hedge the equity risk component of the high yield bond. It is most similar to a convertible arbitrage strategy of being long the convertible bonds and short the underlying common stock.

This paper looks at the possibility of arbitraging mispricings between a company's high yield bond and stock. The argument behind the strategy is that the equity and debt markets quite often react to information differently. For example, stock prices often plunge after a poor earnings announcement. However, the bond market might not incorporate the new information into the price of the company's bond as rapidly. In such a scenario it might be possible to take advantage of the relative mispricings. The important question though is whether such a strategy can be applied universally or if it is very firm and time period specific. Additionally, we try to identify the nature of the relationship between a firm's stock and its bond. For the purpose of this study we focus our efforts on companies with high yield debt. A natural extension of the above is to use call options on the stock. Options derive their return from three sources: the risk free rate, the underlying asset and the volatility of the underlying asset. Thus, in addition to capturing any arbitrage opportunities due to the underlying asset, call options allow us to capture mispricings due to the company's bond exposure to the volatility of its stock.

Theoretical Framework

Capital structure arbitrage is a very recent area. As such there is not a lot of literature available outlining the benefits of the strategy. Currie and Morris (2002) describe capital structure arbitrage as taking a position in a debt security to hedge an equity position or vice-versa. According to their article, the development of the credit risk market is a major reason for the rapid increase in the popularity of capital structure arbitrage.

Arbitrage opportunities arise from the relative mispricings of various forms of capital employed by a firm. For example, arbitraging price discrepancies between the convertible and other forms of debt of a company is the most common form of capital structure arbitrage according to Calamos (2003). Another form is the pricing discrepancy between a company's high yield debt and call options on its stock. However it is imperative that the underlying characteristics of the strategy be thoroughly understood in order to correctly identify arbitrage opportunities. Calamos (2003) outlines some situations under which capital structure arbitrage is feasible. If market valuation of different parts of a company's capital structure varies significantly then a possible arbitrage situation might arise. Securities deviating from their historical relationships and failure of liquidity differences in explaining observed mispricings are other scenarios when capital structure arbitrage might be possible. For any successful implementation of a hedging strategy, risk management is a critical component. Possible sources of risk include the possibility of

mergers or acquisitions adversely impacting one or both sides of the hedge and the Greeks becoming unstable or too expensive to protect.

Merton (1974) and Black and Scholes (1973) developed one of the most important models of relating credit risk to the capital structure of the firm. Ingersoll (1987) and Duffie and Singleton (2003) explain the underlying concepts lucidly. Assuming a lognormal diffusion process with a constant volatility for the firm's assets, the payment to shareholders at time T can be modeled as a call option on the assets of the firm.

If E is the value of the firm's equity and A is the value of its assets such that E_0 and A_0 is the value of the equity and the assets today and E_T and A_T is the value at time T, then the payment to the shareholders at time T is given by,

$$E_T = \max[A_T - D, 0]$$

where, D is the debt payment due at time T. It can be shown that the credit spread s implied by the Merton model is

$$s = -\ln[N(d_2) + N(-d_1)/L]/T$$

where, L is a measure of leverage equal to D_0 / A_0, where D_0 is the present value of D,

$$d_1 = \frac{-\ln(L)}{\sigma_A \sqrt{T}} + 0.5\sigma_A \sqrt{T}; d_2 = d_1 - \sigma_A \sqrt{T}$$

$N(\ )$ is the cumulative probability distribution function for a variable distributed according to the standard normal distribution.

Hull, Nelken and White (2004) build on the above model to compute the credit spreads from implied volatility thereby relating the credit markets with the options markets.

Methodology

Price movement of the underlying stock and the high yield bond's exposure to the stock volatility were examined as possible sources of arbitrage. The methodology was guided by that outlined in Boveroux and Minguet (1999). A beta neutral portfolio (Strategy I) of the firm's stock and the bond was achieved by assigning weights to either asset based on the beta between the stock and the high yield bond as follows:

$$R_p = wR_E + (1-w)R_H$$

Choose w such that,

$$R_P = a + \beta R_E + \varepsilon$$

$$\beta = \frac{Cov(R_P, R_E)}{R_E} = 0$$

To obtain a beta neutral portfolio, we set β to 0. In other words,

$$Cov(R_P, R_E) = 0$$

Substituting the value of R_P from above we get,

$$Cov(wR_E + (1-w)R_H, R_E) = 0$$

or,

$$wVar(R_E) + (1-w)Cov(R_H, R_E) = 0$$

Dividing throughout by $Var(R_E)$,

$$w + (1-w)\frac{Cov(R_H, R_E)}{Var(R_E)} = 0$$

However, $\frac{Cov(R_H, R_E)}{Var(R_E)}$ is the beta (b) of the bond with the stock. Thus we obtain the appropriate weights for the stock and the bond in the portfolio by solving for b as shown below:

$$\begin{aligned} w + (1-w)b &= 0 \\ w &= -\frac{b}{1-b} \\ 1-w &= \frac{1}{1-b} \end{aligned} \qquad (1)$$

where w is the weight assigned to the stock.

The weights are constrained to sum up to one. A potential problem arises if the beta is close to 1. In that case the weight will tend to infinity. To circumvent this possibility a similar analysis to determine the weights was carried out by incorporating the risk free asset in to the portfolio of the firm stock and bond and regressing the excess returns of the bond with the excess returns of the stock. In this case either the stock or the bond was assigned a weight equal to one while the other was unrestricted (equal to the negative of the beta between the excess bond and stock returns). The results were very similar. Thus, we present the former methodology in the interest of brevity.

The second approach (Strategy II) was to use the square of the stock return as a proxy for the volatility of the stock that the use of call options on the stock might capture in addition to the variability of the stock price itself. If a portfolio formed with the stock and the bond of the company with weights determined from equation (1) with the beta computed by regressing the high yield bond against the square of the stock return resulted in positive returns, then it indicates that using call options on the stock and the high yield bond to form a portfolio might yield positive returns.

The two strategies outlined above were implemented on a portfolio of stocks and bonds comprising of the stocks and bonds respectively of the 5 firms that form our sample. A portfolio comprised of the Russell 2000 and the Lehman High Yield indices was formed and tested as well

to investigate the effectiveness of the strategies at the portfolio level as well as to examine the benefits of diversification.

Data

The data for this paper was obtained from Datastream. Firms that had their bonds classified as high yield (junk) were part of the sample. There are three major rating agencies i) Moody's, ii) Standard and Poor's and iii) Fitch Investors Services. We decided to employ both Moody's and Standard and Poor's ratings for this study. Our initial screening criterion was to select the bond issues with a rating of Ba or lower from Moody's or BB or lower from Standard & Poor's. Only companies that had a rating history of high yield through out the time period of our study from January 2001 to December 2003 were selected. A total of 40 companies were found to have high yield bond data available during this period. Additionally, we restricted our sample to firms with high yield bond issues of different maturities. The final sample consisted of 11 firms that had data from January of 2001 to December 2003 for both the equity and the bond issues. Data for the Russell 2000 and the Lehman High Yield indices were collected as well for the period 2001 to 2003.

Empirical Results

We reproduce the results for 5 out of the 11 firms that were studied because the results are very similar in nature. Data for the other firms are available upon request. The five firms were selected so as to represent different industries, thus, allowing us to evaluate the strategies over different time periods and across diverse industries. The firms included in this report are Owens-Ill Inc. (Forest and Paper Products), Host Marriott LP (Real Estate), Circus Circus (Entertainment), Rite Aid Corp (Supermarkets, Drugstores and Mass Merchandisers) and Service Corp Int. (Consumer Services). Additionally, the following portfolios were formed to allow performance comparison at the firm specific and the portfolio level: Portfolio I comprises of the Russell 2000 and Lehman High Yield indices with the weights determined by Strategies I and II; Portfolio II is an equal weighted composition of the stock returns of the 5 firms that form our sample; Portfolio III is an equal weighted composition of the high yield bonds of the 5 firms in our sample and Portfolio IV is constituted from Portfolios II and III according to Strategies I and II.

Exhibit 1a shows the performance of the 5 firms over different rolling time periods for Strategy I. In all cases a beta neutral portfolio is achieved. However, the performance closely mimics the bond. This is due to weights close to 1 that are assigned to the high yield bond while forming the beta neutral portfolio. The very nature of forming the portfolio such that the equity risk is hedged away results in the bond being the primary driver of the portfolio returns. This can be further verified in Exhibit 1b which shows the effectiveness of the strategy at the portfolio level for the same time periods of 2001-02 and 2002-03. The conclusions are similar as that at the firm specific level. Additionally, the betas with the Russell 2000 of Portfolios I and IV are almost 0 indicating the successful hedging of the equity risk.

Exhibit 1a Strategy I

		OWENS-ILL INC			HOST MARRIOTT LP			CIRCUS CIRCUS			RITE AID CORP			SERVICE CORP INT		
		Stock	Bond	Strategy	Stock	Bond	Strategy	Stock	Bond	Strategy	Stock	Bond	Strategy	Stock	Bond	Strategy
2001-02	Return	-18.37%	16.26%	15.25%	-18.37%	0.80%	-2.89%	-7.30%	6.80%	6.78%	-58.01%	-1.54%	-0.60%	-36.572%	8.016%	8.55%
	Std. Dev	42.62%	12.13%	12.73%	42.62%	12.98%	14.20%	44.60%	10.26%	10.31%	78.40%	28.98%	29.41%	72.19%	14.56%	14.80%
2002-03	Return	-8.49%	6.79%	6.76%	6.36%	5.25%	5.17%	25.12%	6.25%	6.35%	81.82%	39.37%	31.83%	10.39%	11.16%	10.44%
	Std. Dev	53.45%	9.80%	9.88%	33.44%	9.83%	10.00%	37.61%	6.82%	6.86%	58.95%	20.92%	21.65%	65.61%	10.75%	10.76%

Exhibit 1b Strategy I

	2001-02			2002-03		
	Return	Std. Dev	Beta with Russell	Return	Std. Dev	Beta with Russell
Russell 2000	-16.52%	24.28%	1.00	8.14%	22.21%	1.00
Lehman HY	-0.08%	5.92%	0.02	12.65%	4.74%	0.01
Portfolio I	-0.38%	6.03%	0.01	21.24%	4.25%	0.01
Portfolio II	-22.03%	32.67%	0.71	30.05%	30.40%	0.90
Portfolio III	7.16%	8.36%	0.01	13.79%	6.07%	-0.01
Portfolio IV	6.59%	8.57%	0.00	12.41%	6.22%	-0.01

Note:
Portfolio I: Composed from Russell 2000 and Lehman High Yield by applying Strategy I.
Portfolio II: Composed from our 5 company sample by equally weighting the Stock returns.
Portfolio III: Composed from our 5 company sample by equally weighting the Bond returns.
Portfolio IV: Composed from the respective bond and stock returns of our sample pool by applying Strategy I.

Exhibits 2a and 2b chart the performance of Strategy II at the firm and portfolio level. Unlike Strategy I, the results here are mixed with the strategy doing very well in some cases (Circus Circus in 2001-02) by providing reasonably high returns but with much lower volatilities while in other cases the strategy returns either very high positive or negative returns accompanied by very high volatilities (Rite Aid Corp. 2001-02 and 2002-03). However it does much better at the portfolio level (both for Portfolio I and IV) over the same periods. This indicates that there might be a relationship between high yield bonds and option on the stock but it is effective at the portfolio level rather than the firm specific level. However, the portfolios formed are not beta neutral with respect to the Russell 2000 despite being quite low for the case of Portfolio IV. In order to ascertain if hedging was accomplished in the case of Portfolio IV we compared the betas of Portfolio II with Russell 2000 and Portfolio IV with Russell 2000 and concluded that significant hedging is achieved even with a portfolio of 5 companies.

Exhibit 2a Strategy II

		OWENS-ILL INC			HOST MARRIOTT LP			CIRCUS CIRCUS			RITE AID CORP			SERVICE CORP INT		
		Stock	Bond	Strategy	Stock	Bond	Strategy	Stock	Bond	Strategy	Stock	Bond	Strategy	Stock	Bond	Strategy
2001-02	Return	-18.37%	16.26%	7.29%	-21.92%	0.36%	14.48%	-7.30%	6.80%	10.09%	-58.01%	-1.54%	-61.07%	-36.57%	8.02%	-2.28%
	Std. Dev	42.62%	12.13%	20.06%	43.06%	13.12%	162.41%	44.60%	10.26%	11.16%	78.40%	28.98%	93.13%	72.19%	14.56%	23.17%
2002-03	Return	-8.49%	6.79%	-3.85%	6.36%	5.25%	4.27%	25.12%	6.25%	52.62%	81.82%	39.37%	97.95%	10.39%	11.16%	-31.84%
	Std. Dev	53.45%	9.80%	16.79%	33.44%	9.83%	14.31%	37.61%	6.82%	147.14%	58.95%	20.92%	122.78%	65.61%	10.75%	35.93%

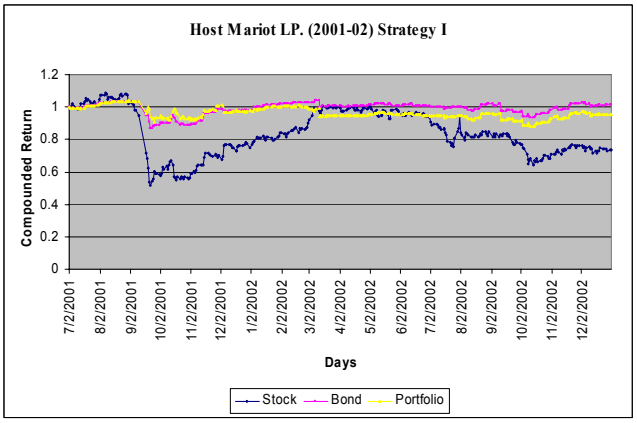
Exhibit 2b Strategy II

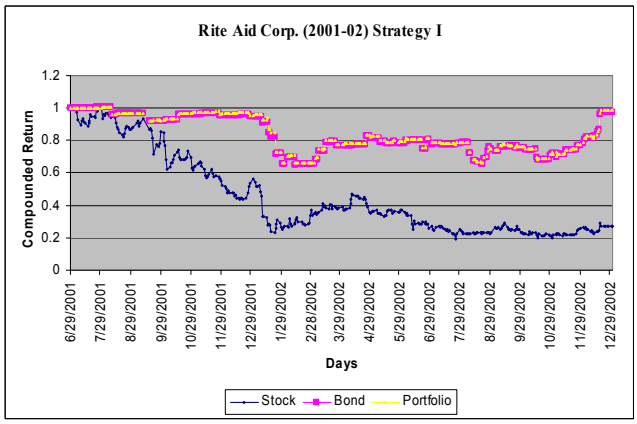
	2001-02			2002-03		
	Return	Std. Dev	Beta with Russell	Return	Std. Dev	Beta with Russell
Russell 2000	-16.52%	24.28%	1.00	8.14%	22.21%	1.00
Lehman HY	-0.08%	5.92%	0.02	12.65%	4.74%	0.01
Portfolio I	33.42%	20.90%	0.30	49.69%	87.97%	0.79
Portfolio II	-22.03%	32.67%	0.71	30.05%	30.40%	0.90
Portfolio III	7.16%	8.36%	0.01	13.79%	6.07%	-0.01
Portfolio IV	13.14%	37.00%	0.02	52.74%	38.76%	0.17

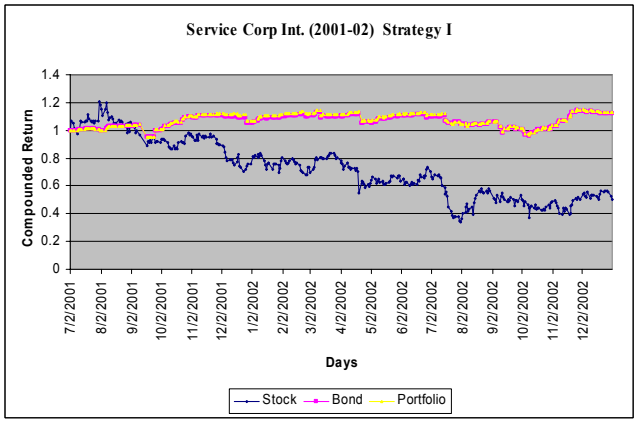
Note:
Portfolio I: Composed from Russell 2000 and Lehman High Yield by applying Strategy II.
Portfolio II: Composed from our 5 company sample by equally weighting the Stock returns.
Portfolio III: Composed from our 5 company sample by equally weighting the Bond returns.
Portfolio IV: Composed from the respective bond and stock returns of our sample pool by applying Strategy II.

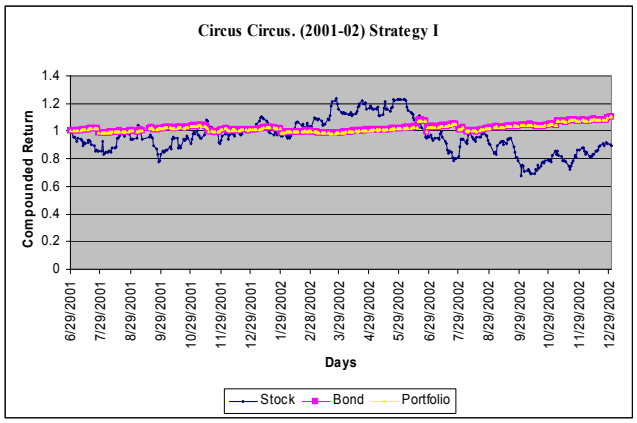
Exhibits 3a and 3b graph the returns for Strategy I at the firm and portfolio level. As mentioned earlier the returns are driven primarily by the bond.

Exhibit 3a Strategy I (Beta Neutral) Returns at the Firm Level (2001-02)









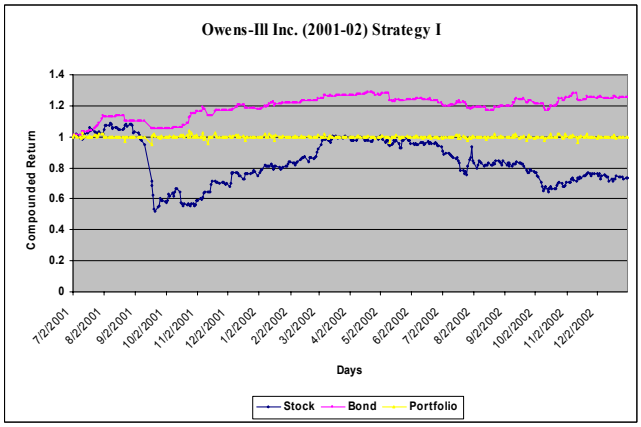
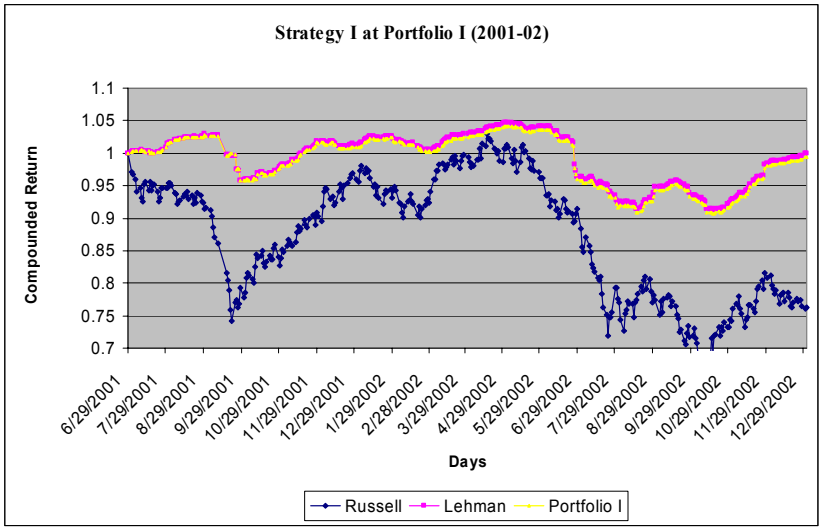
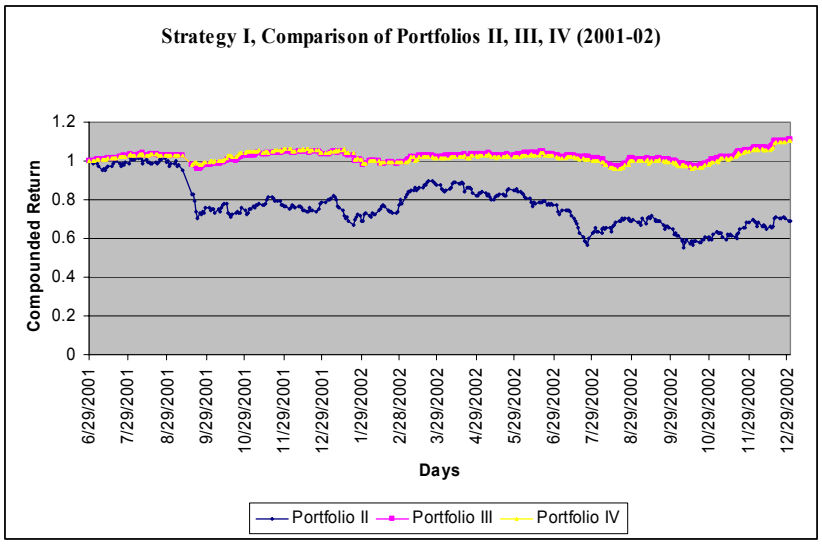


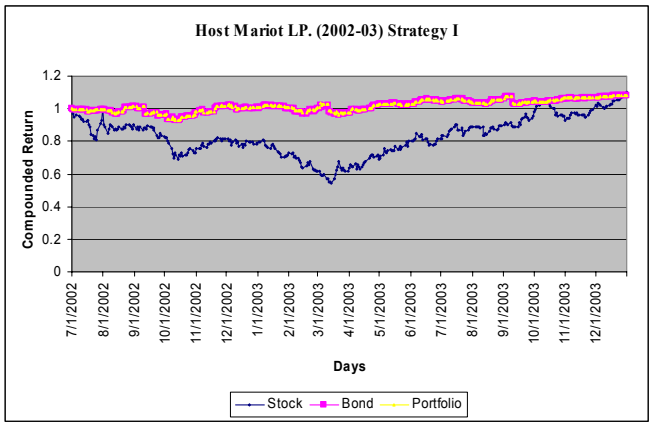
Exhibit 3b Strategy I (Beta Neutral) Returns at the Portfolio Level (2001-02)

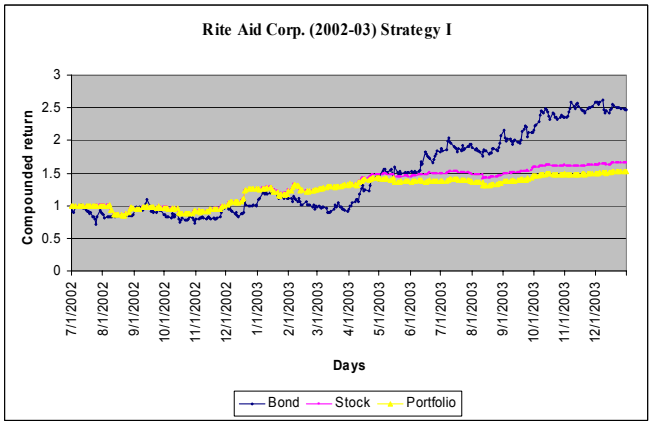


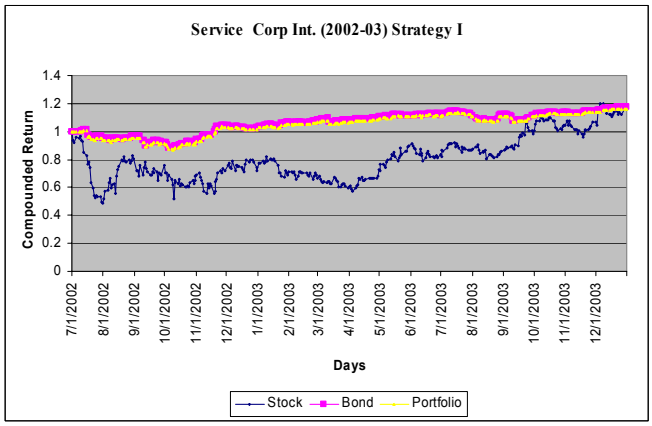


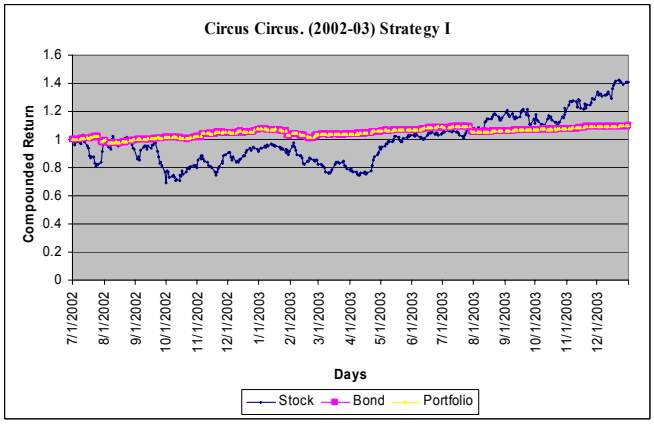
Comparing Exhibits 3 and 4 leads to similar conclusions for Strategy I irrespective of the time period being studied.

Exhibit 4a Strategy I (Beta Neutral) Returns at the Firm Level (2002-03)









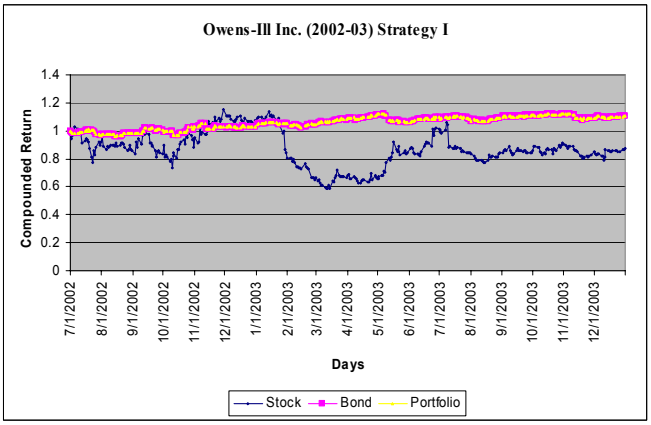
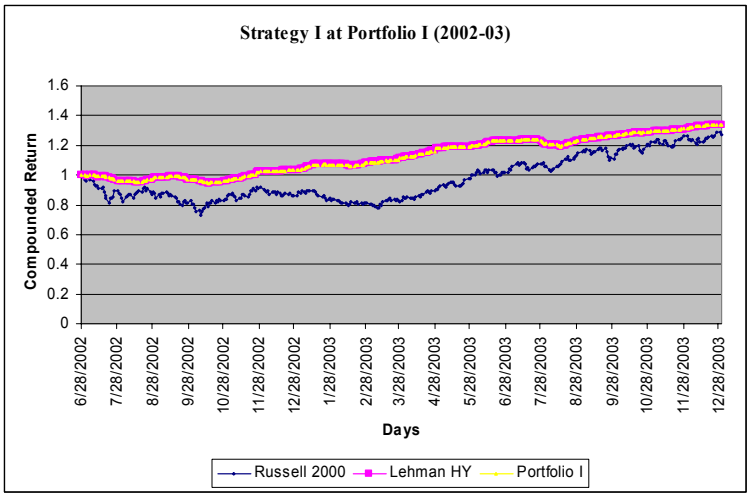
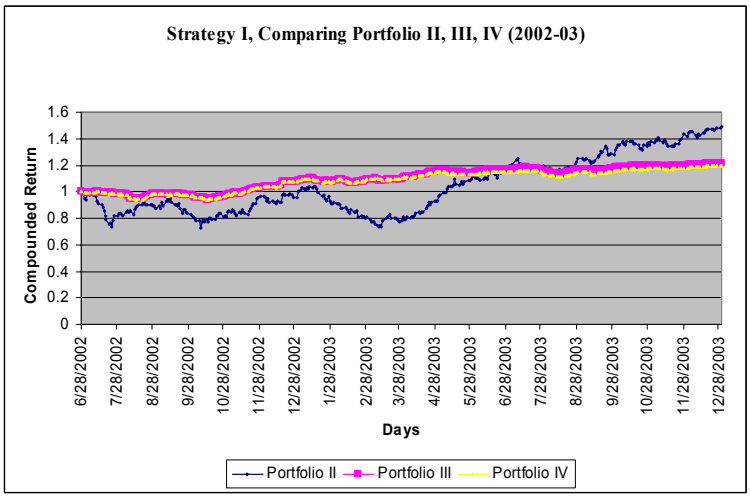


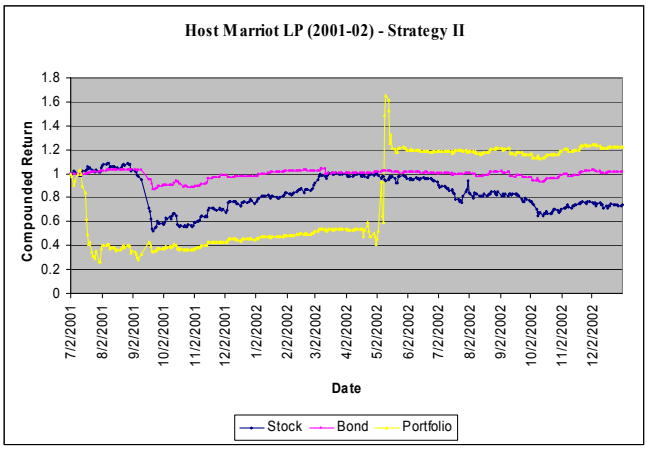
Exhibit 4b Strategy I (Beta Neutral) Returns at the Portfolio Level (2002-03)

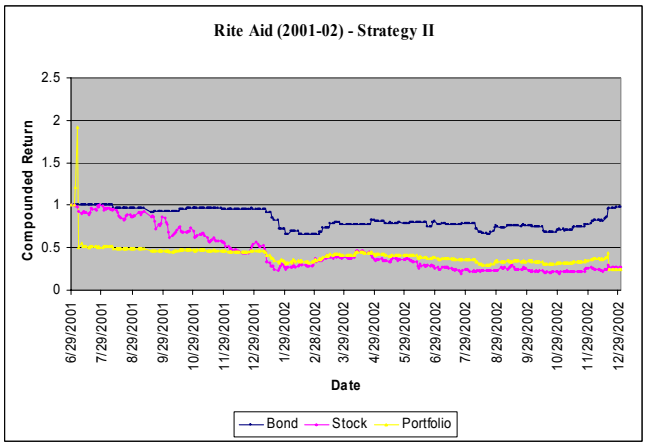


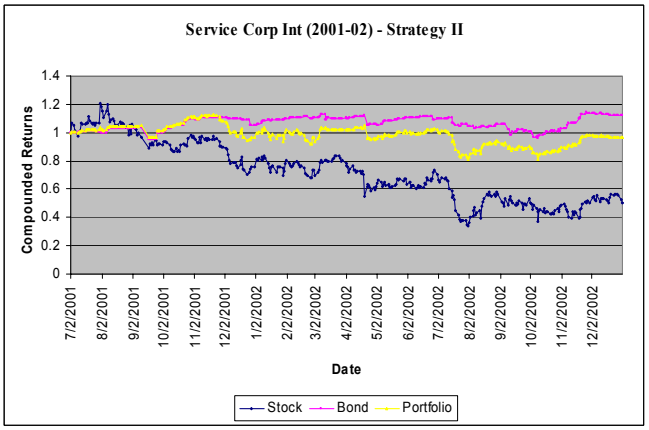


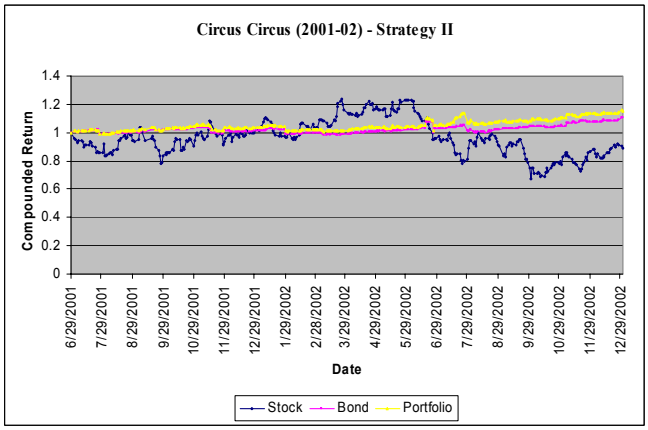
Exhibits 5 and 6 graph the performance of Strategy II over different time periods both at the firm specific and at the aggregate level. For portfolios comprised of the individual firm stock and bond, the strategy works well in some cases (Circus Circus 2001-02) while it does not do very well for others (Rite Aid 2001-02 and 2002-03). This makes it difficult to conclude about the effectiveness of the strategy at the firm level.

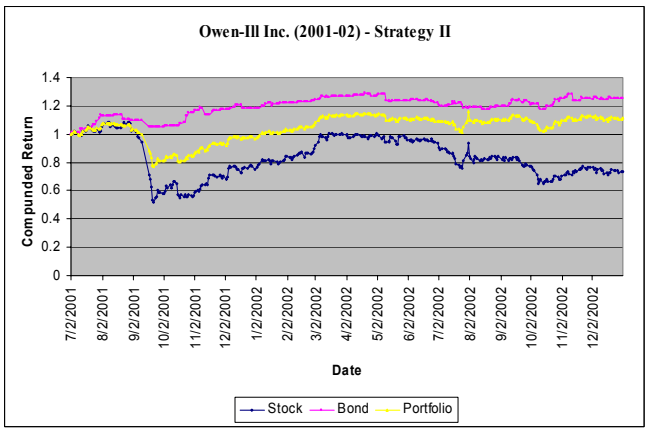
Exhibit 5a Strategy II Returns at the Firm Level (2001-02)





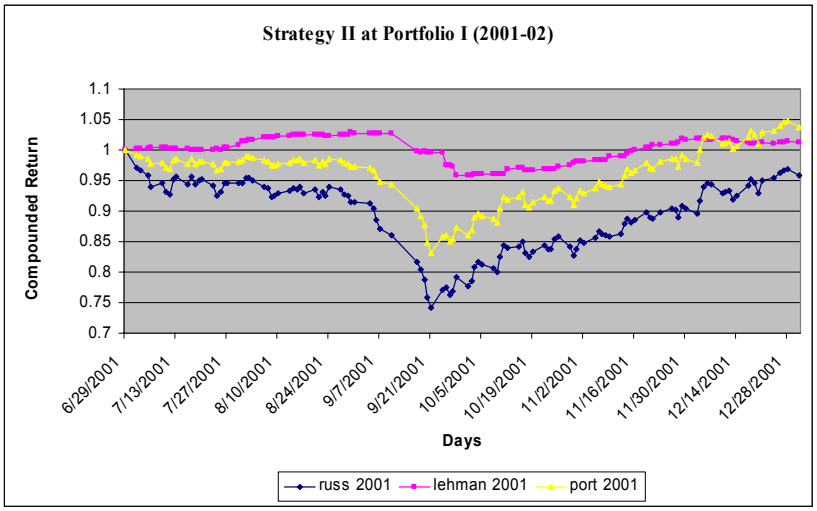






However, at the aggregate level the strategy performs quite well indicating that executing this strategy at the portfolio level is more effective since the firm specific risk can be diversified away. This is true even for Portfolio IV indicating that a large number of firms are not needed to diversify non-systematic risk. It must be noted though that the equity risk of the portfolios is not hedged away completely, unlike Strategy I, although it is quite low for Portfolio IV. The hedging that we witness is not easily justified. Additional study is required before we can reach further conclusions.

Exhibit 5b Strategy II Returns at the Portfolio Level (2001-02)



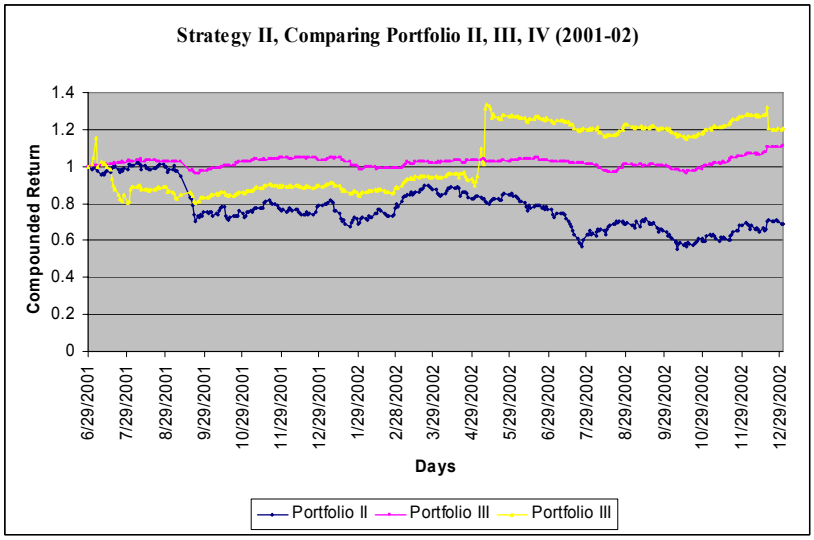
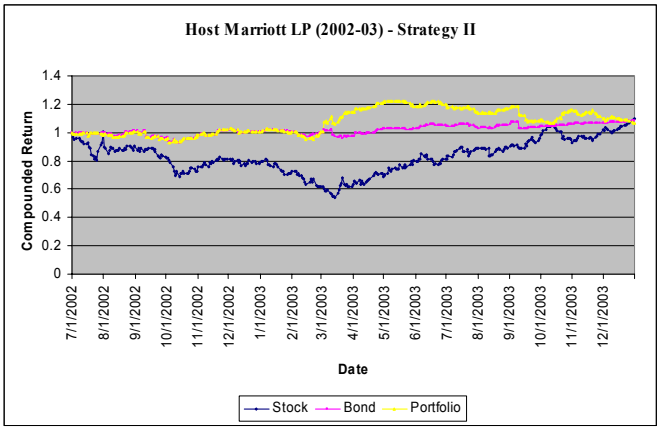
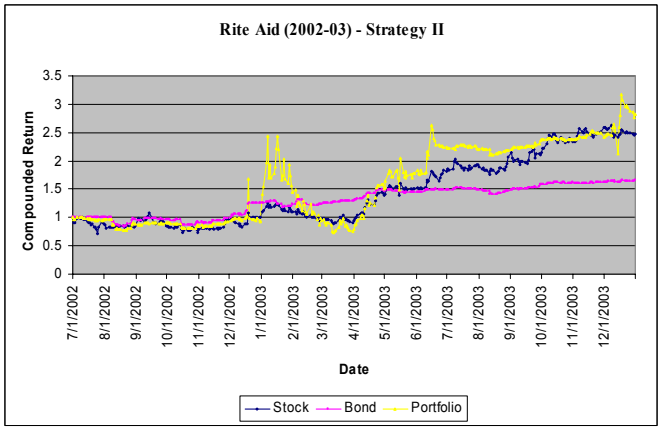
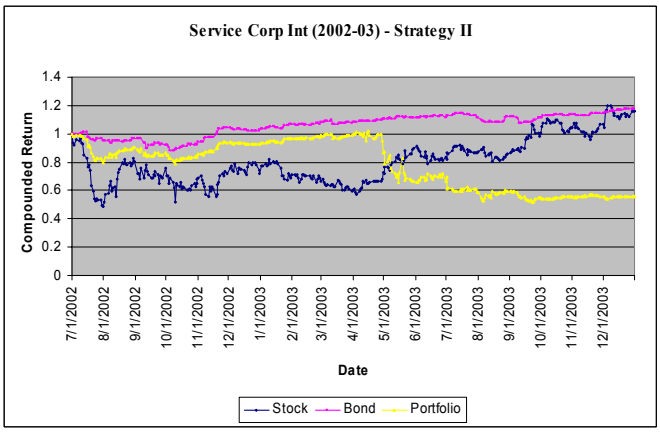
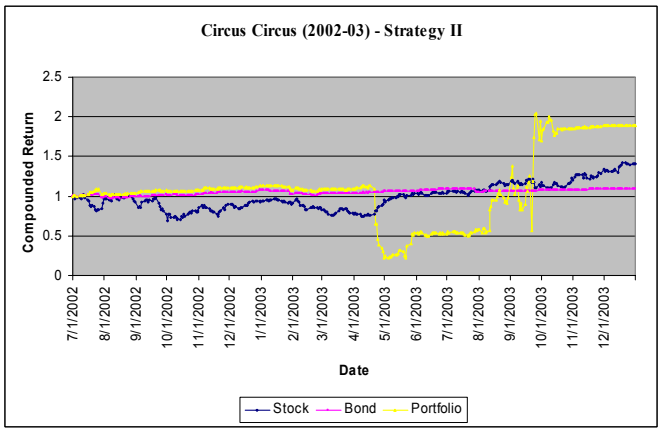


Exhibit 6a Strategy II Returns at the Firm Level (2002-03)









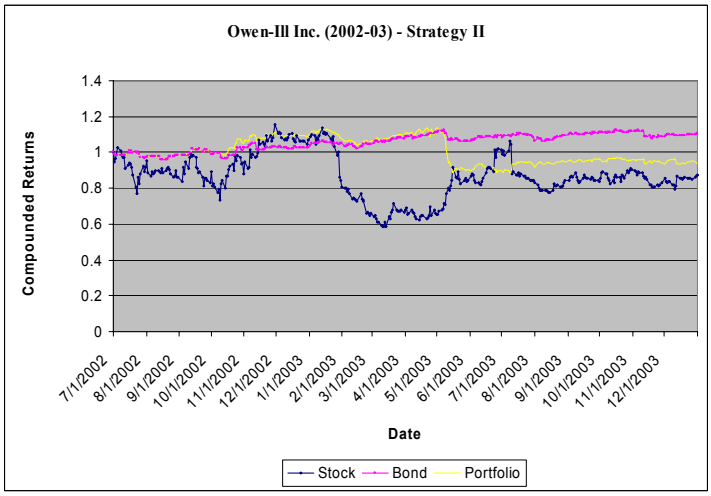
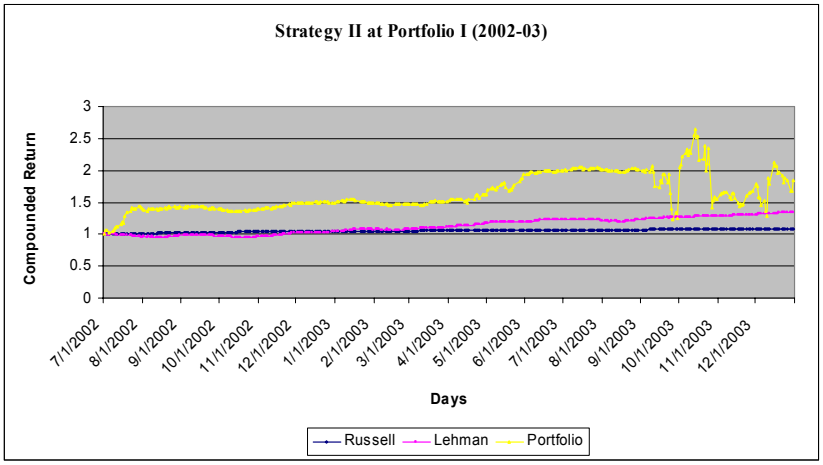
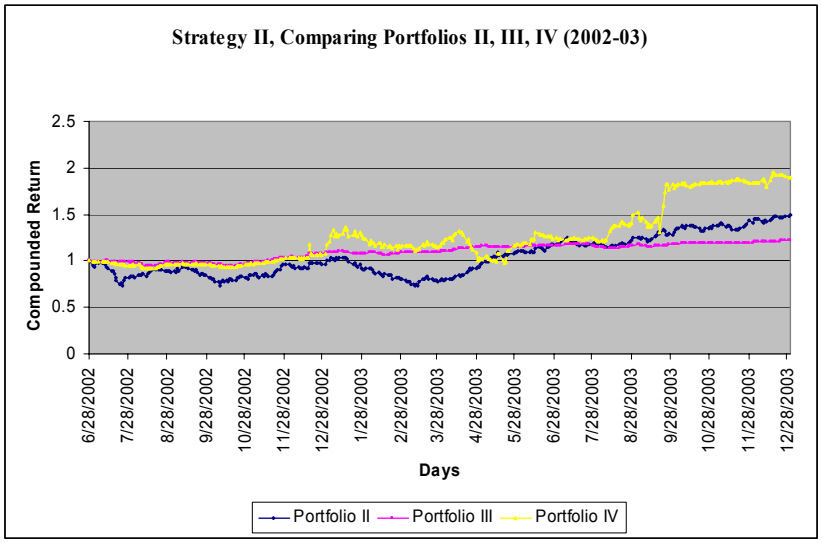


Exhibit 6b Strategy II Returns at the Portfolio Level (2002-03)





Conclusions

In this paper we carried out an empirical analysis of Capital Structure Arbitrage. Two strategies were tested both at the individual firm level and at the aggregate portfolio level over different time periods. In Strategy I we investigated the possibility of arbitrage due to the movement of the stock price. While it resulted in beta neutral portfolios in all instances, the high yield bond turned out to be the primary determinant of return and volatility for the portfolios. Strategy II examined the use of the square of the stock return as a proxy for the volatility of the stock that the use of call options on the stock might capture in addition to the variability of the stock price itself. Results indicate that the strategy does not work in a predictable manner at the firm level but does quite well at the aggregate portfolio level. If it does work at the portfolio level then capital structure arbitrage using call options and high yield bonds might be a feasible strategy. Further analysis is needed before a more conclusive verdict can be reached.

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