

**RISK AND RETURN IN FIXED INCOME ARBITRAGE:  
NICKELS IN FRONT OF A STEAMROLLER?**

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## **ABSTRACT**

We conduct an analysis of the risk and return characteristics of fixed income arbitrage. We show that a widely-used fixed income arbitrage strategy based on swap spreads generates sizable positive excess returns over an extended period. We find, however, that most of these excess returns represent compensation for risk; there is very little “arbitrage” in this fixed income arbitrage strategy. Furthermore, these excess returns are related to those in the stock market as well as in the Treasury and corporate bond markets. This suggests that the risk of a major financial event or crisis is a common risk factor priced in many financial markets.

## 1. INTRODUCTION

During the hedge-fund crisis of 1998, market participants were given a revealing glimpse into the proprietary trading strategies used by a number of large hedge funds such as Long Term Capital Management (LTCM). Among these strategies, few were as widely used—or as painful—as fixed income arbitrage. Virtually every major investment banking firm on Wall Street reported losses directly related to their positions in fixed income arbitrage during the crisis. Despite these losses, however, fixed income arbitrage has become one of the most-popular and rapidly-growing sectors within the hedge-fund industry. For example, the Tremont/TASS (2003) Asset Flows Report indicates that \$10.4 billion was invested in fixed income arbitrage hedge funds during 2003 and that the total amount of hedge fund capital devoted to fixed income arbitrage is now nearly \$36 billion.<sup>1</sup>

This mixed history raises a number of important issues about the fundamental nature of fixed income arbitrage. Is fixed income arbitrage truly arbitrage? Or is it merely a strategy that earns small positive returns most of the time, but occasionally experiences dramatic losses (a strategy often described as picking up nickels in front of a steamroller)? Were the large fixed income arbitrage losses during the hedge-fund crisis simply due to excessive leverage, or are there deeper reasons arising from the inherent nature of these strategies? To address these issues, this paper conducts an extensive analysis of the risk and return characteristics of fixed income arbitrage.

Fixed income arbitrage is actually a broad set of market-neutral investment strategies intended to exploit valuation differences between various fixed income securities or contracts. In this analysis, we focus on what has probably been the most-important and widely-used type of fixed income arbitrage strategy, swap-spread arbitrage. In its simplest form, this strategy involves taking offsetting long and short positions in a swap and a Treasury bond. The importance of this strategy in fixed income arbitrage is evidenced by the fact that swap-spread positions represented the single-largest source of losses for LTCM.<sup>2</sup> Furthermore, the hedge fund crisis revealed that many other ma-

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<sup>1</sup>See Appendix D of the Tremont/TASS (2003) report. The total amount of capital devoted to fixed income arbitrage is likely much larger since the Tremont/TASS report covers less than 50 percent of the total estimated amount of capital managed by hedge funds. Also, many Wall Street firms directly engage in proprietary fixed income arbitrage trading.

<sup>2</sup>Lowenstein (2000) reports that LTCM lost \$1.6 billion in their swap-spread positions before their collapse. The second-largest source of losses was in equity-volatility positions where LTCM lost \$1.3 billion.

major investors had similar exposure to swap spreads; Salomon Smith Barney, Goldman Sachs, Morgan Stanley, BankAmerica, Barclays, and D.E. Shaw all experienced major losses in swap-spread strategies.<sup>3</sup>

At first glance, swap-spread arbitrage appears similar to the simple strategy of buying corporate bonds and shorting Treasuries. Since corporate yields are higher than Treasury yields, this simple strategy generates a stream of positive cash flows equal to the spread *provided* that default does not occur. If there is a default, of course, then this strategy suffers a large loss. What is different about swap-spread arbitrage, however, is that there is no *direct* default risk in a swap contract because the cash flows are not the obligations of the banks quoting Libor rates. Thus, even if these banks default on their debt, the counterparties to a swap continue to exchange fixed for floating cash flows.<sup>4</sup> One reason for the popularity of this strategy may be the belief that an arbitrageur earns a default risk premium without bearing any default risk.

The swap-spread strategy, of course, is not actually an arbitrage in the textbook sense since the arbitrageur is exposed to *indirect* default risk. This is because if the viability of a number of major banks were to become uncertain, market Libor rates would likely increase significantly. For example, the spread between bank CD rates and Treasury bill yields spiked to nearly 500 basis points around the time of the Oil Embargo during 1974. In this situation, a swap-spread arbitrageur paying Libor on a swap would suffer large negative cash flows from the strategy as the Libor rate responded to increased default risk in the financial sector. In addition to this event risk, swap-spread arbitrageurs are also exposed to the usual mark-to-market variation in the value of their positions. Thus, an arbitrageur with too little capital could face margin calls and be forced to unwind his position at a loss prior to convergence.<sup>5</sup>

As in Mitchell and Pulvino (2001), our primary approach will be to follow specific trading strategies through time and construct return indexes that we then study. There are several important advantages to this approach. First, it allows us to study

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<sup>3</sup>See Siconolfi, Raghavan, Pacelle, and Sesit (1998), Beckett and Pacelle (1998), Dunbar (2000), and Lowenstein (2000).

<sup>4</sup>In theory, there is the risk of a default by a counterparty. In practice, however, this risk is negligible since swaps are usually fully collateralized under master swap agreements between major institutional investors. Furthermore, the actual default exposure in a swap is far less than for a corporate bond since notional amounts are not exchanged. Following Duffie and Huang (1996), Duffie and Singleton (1997), Minton (1997), He (2000), Grinblatt (2001), Liu, Longstaff, and Mandell (2002), and many others, we abstract from the issue of counterparty credit risk in this analysis.

<sup>5</sup>For discussions of these types of limits-to-arbitrage issues, see Schleifer and Vishny (1997), Loewenstein and Willard (2000a, b), and Liu and Longstaff (2004).

the returns from a specific strategy from its inception to its final convergence or maturity date. Second, it allows us to hold fixed the effects of leverage in the analysis and focus more directly on the risk and return characteristics of the strategies. Third, this approach allows us to study returns over a much longer horizon than would be possible using the limited amount of reliable hedge fund return data available. Finally, this approach allows us to avoid the potential survivorship biases in reported hedge fund return indexes.

We begin by describing the economics of the swap-spread arbitrage strategy. The primary risk faced by an arbitrageur (assuming he has access to sufficient capital to withstand temporary mark-to-market losses) is financial-event risk. Since there were no major spikes in the Libor spread during the 15-year sample period, it is not surprising that individual swap-spread trades had very favorable investment properties. In particular, trading opportunities occurred frequently and virtually all of the swap-spread trades generated large positive excess returns. The few exceptions resulted in only minor losses.

We next explore the risk and return characteristics of this fixed income arbitrage strategy. We find that this strategy results in average annualized excess returns ranging from about one to six percent, depending on the horizon of the strategy. Furthermore, the Sharpe ratios for this swap-spread strategy range from about 0.40 to 0.70. These values are very similar to those reported by industry sources for actual fixed income arbitrage hedge fund returns.

These positive results seem to suggest that fixed income arbitrage represents an attractive alternative asset class for investors. The situation changes, however, when we explore the extent to which these positive excess returns represent compensation for bearing market risk. Surprisingly, virtually all of the excess returns generated by this fixed income arbitrage strategy are directly attributable to market risk. In particular, none of the alphas for the fixed income arbitrage strategies are statistically different from zero after controlling for risk. Furthermore, the excess returns are significantly related to the excess returns on the stock market, bank stocks, Treasury bonds, and bank debt. This suggests that financial-event risk may be a common factor affecting the expected returns of assets in many different markets. We repeat the tests using actual fixed income arbitrage hedge fund return data from several industry sources and find results very similar to those for our return indexes. These results have important implications for the hedge-fund sector.

This paper contributes to the rapidly-growing literature on returns to “arbitrage” strategies. Closest to our paper are the important recent studies by Mitchell and Pulvino (2001, 2002) that focus on the returns from merger arbitrage or other types of equity arbitrage strategies. This paper focuses exclusively on fixed income arbitrage. Like Mitchell and Pulvino, however, we find that the excess returns for a popular arbitrage strategy are largely compensation for the risk of an infrequent event. Less related to our work are a number of important recent papers focusing on the actual

returns reported by hedge funds. These papers include Fung and Hsieh (1997, 2001, 2002), Ackermann, McEnally, and Ravenscraft (1999), Brown, Goetzmann, and Ibbotson (1999), Brown, Goetzmann, and Park (2000), Dor and Jagannathan (2002), Brown and Goetzmann (2003), Getmansky, Lo, and Makarov (2003), and Agarwal and Naik (2004). Our paper differs from these in that the returns we study are attributable to a specific strategy, whereas reported hedge fund returns are generally composites of multiple (and offsetting) strategies with varying degrees of leverage.

The remainder of this paper is organized as follows. Section 2 describes the nature and mechanics of the swap-spread fixed income arbitrage strategy. Section 3 describes the data used in the study. Section 4 discusses how the strategy is implemented. Section 5 explains how the return indexes are constructed and analyzes the risk and return characteristics of the strategies. Section 6 conducts an analysis of historical fixed income arbitrage hedge fund returns. Section 7 summarizes the results and makes concluding remarks.

## 2. THE TRADING STRATEGY

In this section, we describe the mechanics and underlying economics of the swap-spread strategy. This strategy has traditionally been one of the more popular leveraged strategies used by fixed income hedge funds and proprietary-trading desks on Wall Street.

The swap-spread strategy is a simple trade that benefits when the long-term swap spread  $SS$  differs from the short-term swap spread  $S_t$ . In its simplest form, the strategy has two legs. In the first, an arbitrageur enters into a par swap and receives a fixed coupon rate  $CMS$  and pays the floating Libor rate  $L_t$ . In the second, the arbitrageur shorts a par Treasury bond with the same maturity as the swap and invests the proceeds in a margin account earning the repo rate. The cash flows from the second leg consist of paying the fixed coupon rate on Treasury bond  $CMT$  and receiving the repo rate from the margin account  $r_t$ .<sup>6</sup> Combining the cash flows from the two legs shows that the arbitrageur receives a fixed annuity of  $SS = CMS - CMT$  and pays the floating spread  $S_t = L_t - r_t$ . Table 1 illustrates the cash flows from a stylized version of this strategy.<sup>7</sup> The cash flows from the reverse or short version of

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<sup>6</sup>The terms  $CMS$  and  $CMT$  are widely-used industry abbreviations for constant maturity swap rate and constant maturity Treasury rate.

<sup>7</sup>In actuality, fixed coupons are paid on a semiannual actual/actual basis, while the Libor and repo rates are paid on an actual/360 quarterly basis. To make the cash flows from the short transaction parallel those from the swap, we assume that  $r$  represents the collateral rate for a three-month horizon (this assumption is for convenience and has little effect on the results). The Libor and repo rates are determined one quarter prior to the date at which they are paid. This convention is known as setting in

the strategy are given by reversing the signs of the cash flows in Table 1. There are no initial or terminal principal cash flows in this strategy; the cash flows are entirely from the exchange of the fixed spread  $SS$  for the floating spread  $S_t$ .

The swap-spread strategy is thus a simple bet on whether the fixed annuity of  $SS$  received will be larger than the floating spread  $S_t$  to be paid. If the swap spread  $SS$  is larger than the average value of  $S_t$  during the life of the strategy, the strategy is profitable (at least in an accounting sense). What makes the strategy attractive to hedge funds is that the floating spread  $S_t$  has historically been very stable over time, averaging 27.3 basis points with a standard deviation of only 13.4 basis points during the past 15 years. Furthermore, the floating spread  $S_t$  is rapidly mean reverting. Thus, the expected average value of the floating spread over, say, a five-year horizon may have a standard deviation of only 3 to 4 basis points. Because of the extremely low volatility of the average value of the floating spread, many fixed income arbitrage funds view the floating spread as virtually constant and consider the swap-spread strategy as a nearly riskfree arbitrage whenever the swap spread  $SS$  is more than, say, 10 or 20 basis points away from the long-term mean of  $S_t$ .

The swap-spread strategy is, of course, not a riskless arbitrage in the textbook sense. As discussed early, even though an arbitrageur does not face any *direct* default risk (since swap counterparties continue to exchange cash flows even if some of the banks quoting Libor rates default), the arbitrageur does face *indirect* default risk. Specifically, the primary risk faced by an arbitrageur is that of a major event or crisis in the financial markets where the Libor-repo spread  $S_t$  widens by hundreds of basis points. To understand the nature of this event-related risk, it is useful to review the mechanics of how the Libor rate is determined. Each trading day at approximately 11:00 AM London time, the British Bankers Association polls a set of 16 major multinational banks for their offered rates on dollar-denominated deposits for various horizons ranging from overnight to 12 months. The 16 banks in the polled set are generally highly rated; the typical credit rating for a bank in the polled set is AA or A. Once rates are collected from the banks, the highest and lowest four rates are dropped and the official Libor fixing is the average of the rates for the remaining eight banks. If one of the 16 banks were to decline significantly in credit quality or face financial distress, it would likely be quickly replaced in the polled set by another bank. For an in-depth discussion of the “refreshed” credit quality of Libor rates, see Collin-Dufresne and Solnik (2001).

Because of these features, the Libor rate should be largely unaffected by the idiosyncratic default risk of the banks in the polled set. Rather, the Libor rate reflects the economic strength of the entire financial and banking sector. This follows since the only way in which the Libor rate could suddenly widen in response to credit risk would be if more than four of the major banks in the polled set were to drop in credit quality

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advance and paying in arrears.

and alternative banks with higher credit ratings could not be found. Such an event would reflect a major systematic crisis in the financial and banking system. Since Libor is based on quoted rates, it is directly affected by credit spreads in the financial markets, but not by the actual default of a specific bank in the polled set because that bank would be quickly dropped from the sample. Furthermore, quoted rates are for newly originated deposits, and are not based on the prices of previously issued debt. Thus, the fundamental risk inherent in the swap-spread strategy is that of a major financial event or crisis that causes the Libor-repo spread to widen significantly.

Finally, Table 1 illustrates the contractual cash flows associated with this strategy. In reality, an arbitrageur implementing this strategy might face additional cash flows. In particular, since the short Treasury position creates a liability for the arbitrageur, the party lending the Treasury bond might require the arbitrageur to put up additional collateral besides the proceeds from the short sale. For example, if the arbitrageur shorts a bond worth 100, the arbitrageur would typically need to place somewhere between 100 to 105 as collateral into the margin account. The additional amount required as collateral is often referred to as a “haircut.” In this trading strategy, the arbitrageur would have an initial cash outflow equal to amount of the haircut. As the value of the trade fluctuates, a highly-leveraged arbitrageur might also face additional cash outflows in the form of margin calls. In this paper, we abstract from these important leverage issues by simply requiring that the arbitrageur place sufficient capital into the margin account initially to avoid future margin calls. This has the important advantage of allowing us to focus directly on the risk and return characteristics of the swap-spread strategy without confounding them with the well-known effects of leverage on returns.

### 3. THE DATA

In studying the returns from fixed income arbitrage, we use an extensive data set from the swap and Treasury markets covering the period from November 1988 to February 2004. This horizon covers most of the active period for the U.S. swap market.

The swap data for the study consist of month-end observations of the three-month Libor rate and midmarket swap rates for two-, three-, five-, seven-, and ten-year maturity swaps. These maturities represent the most liquid and actively traded maturities for swap contracts. All of these rates are based on end-of-trading-day quotes available in New York to insure comparability of the data. In estimating the parameters, we are careful to take into account daycount differences among the rates since Libor rates are quoted on an actual/360 basis while swap rates are semiannual bond equivalent yields. There are two sources for the swap data. The primary source is the Bloomberg system which uses quotations from a number of swap brokers. The data for Libor rates and for swap rates from the pre-1990 period are provided by Citigroup. As an independent check on the data, we also compared the rates with quotes obtained



from Datastream and found the two sources of data to be very similar.

The Treasury data consist of month-end observations of the constant maturity Treasury (CMT) rates published by the Federal Reserve in the H-15 release for maturities of two, three, five, seven, and ten years. These rates are based on the yields of currently traded bonds of various maturities and reflects the Federal Reserve's estimate of what the par or coupon rate would be for these maturities if the Treasury were to issue these securities. CMT rates are widely used in financial markets as indicators of Treasury rates for the most-actively-traded bond maturities. Since CMT rates are based heavily on the most-recently-auctioned bonds for each maturity, CMT rates provide an accurate estimate of yields for the most-liquid on-the-run Treasury bonds. As such, these rates are more likely to reflect actual market prices than quotations for less-liquid off-the-run Treasury bonds. Finally, data on three-month general collateral repo rates are obtained from Bloomberg as well as Citigroup.

Table 2 presents summary statistics for the Libor-repo spread along with the two-, three-, five-, and ten-year swap spreads. As described earlier, the Libor-repo spread has a mean of 27.3 basis points and a standard deviation of 13.4 basis points. The swap spreads average between 37 and 57 basis points during the sample period, with standard deviations on the order of 19 to 25 basis points. This illustrates that swap spreads tend to be larger and more volatile than the underlying Libor-repo spread.

Figure 1 plots the time series of the spread  $S_t$  over the 1988 to 2004 sample period. As shown, the Libor-repo spread is generally on the order of 20 to 30 basis points, but with occasional short-term spikes to values greater than 50 basis points. In implementing the swap-spread strategy, it will be useful to have an estimate of the expected average value of  $S_t$  over various horizons. As one way of doing this, we assume that the dynamics of the spread are given by,

$$dS = (\mu - \kappa S) dt + \sigma dZ, \tag{1}$$

where  $\mu$ ,  $\kappa$ , and  $\sigma$  are constants and  $Z_t$  is a standard Brownian motion.<sup>8</sup> This process is a simple mean-reverting Ornstein-Uhlenbeck or Vasicek (1977) type of process. To estimate the parameters of this process, we regress monthly changes in the spread  $S$  on the lagged value of the spread. The resulting regression coefficients imply that the dynamics of the spread  $S_t$  are well described by the process,

$$dS = (1.0717 - 3.9604 S) dt + 0.3464 dZ. \tag{2}$$

These dynamics imply that the long-run steady-state mean and standard deviation of

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<sup>8</sup>We also explore other dynamic specifications for the spread. These alternative specifications result in expected average values of  $S_t$  virtually indistinguishable from those implied by the process in Equation (1).

$S_t$  are 27.1 and 12.3 basis points respectively, which agrees closely with the historical values reported in Table 2.

To determine the expected average value of  $S_t$  over the next  $T$  periods, we first solve the stochastic differential equation above for  $S_t$  and then integrate the solution over  $T$  periods. Taking the expectation of the resulting expression gives

$$E_t \left[ \frac{1}{T} \int_t^{t+T} S_\tau d\tau \right] = \frac{\mu}{\kappa} + \frac{1}{\kappa T} \left( S_t - \frac{\mu}{\kappa} \right) (1 - e^{-\kappa T}). \quad (3)$$

To illustrate the expression, Figure 2 plots the expected average value of the spread  $S_t$  over a two-, three-, five-, and ten-year horizon for each month during the sample period. Also shown are the actual two-, three-, five-, and ten-year swap spreads.<sup>9</sup> As illustrated, the expected average value of the spread  $S_t$  displays far less variation than do the swap spreads. Furthermore, there are often large differences between the swap spreads and the expected average values of the spread  $S_t$ .

#### 4. IMPLEMENTING THE STRATEGY

To make the intuition behind the results as clear as possible, we will implement the swap-spread strategy in a very simple way. Clearly, however, much more sophisticated trading approaches and refinements could be employed.

Over its life, the swap-spread strategy experiences a positive cumulative cash flow whenever the swap spread  $SS$  exceeds the average value of the short-term spread  $S_t$  (and similarly for the reverse strategy). Thus, a very simple way to implement the strategy is to initiate a trade whenever the current swap spread  $SS$  differs by some fixed amount from the expected average value of  $S_t$  over the trading horizon.

Given the expression for the expected average value of the spread in Equation (3), we adopt the rule of initiating the swap-spread strategy whenever the current swap spread is more than 10, 20, or 30 basis points greater than (or less than) the expected average value. Once executed, the strategy is held until either the horizon date of the swap and bond, or until the strategy converges. Convergence occurs when the swap spread for the remaining horizon of the strategy is less than or equal to (greater than or equal to) the expected average value of the spread  $S_t$  over the remaining horizon of the strategy.

To calculate the returns from the strategy, several additional aspects need to be specified: the amount of leverage employed (margin requirements), transaction costs,

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<sup>9</sup>We focus on these horizons throughout the analysis since these are the most liquid swap maturities.

and the valuation methodology. Turning first to the issue of leverage, recall that our objective is to focus on the underlying economics of the strategy. The effects of leverage are already well known; leverage increases both excess returns and return volatility proportionally, but leaves Sharpe ratios largely unaffected. To abstract from the effects of leverage in the analysis, we will simply assume that the arbitrageur employs only a modest amount of leverage and has access to sufficient additional capital to meet any margin calls. Thus, the arbitrageur is never forced out of a position early because of mark-to-market losses. Specifically, we assume that for each \$100 notional amount of the strategy, the arbitrageur puts \$10 of capital into the margin account. As we will show, this level of capital is large enough that the arbitrageur never experiences as much as a 20 percent drawdown during the sample period.<sup>10</sup>

For transaction costs, we assume values that are relatively large in comparison to those paid by large institutional investors such as major fixed income arbitrage hedge funds. In a recent paper, Fleming (2003) estimates that the bid-ask spread for actively-traded Treasuries is 0.20 32nds for two-year maturities, 0.39 32nds for five-year maturities, and 0.78 32nds for ten-year maturities. To be conservative, we assume that the bid-ask spread for Treasuries is one 32nd. Similarly, typical bid-ask spreads for actively-traded swap maturities are on the order of 0.50 basis points. We assume that the bid-ask spread for swaps is 1.00 basis points. Finally, we assume that the repo bid-ask spread is 10 basis points. Thus, the repo rate earned on the proceeds from shorting a Treasury bond are 10 basis points less than the cost of financing a Treasury bond. This value is based on a number of discussions with bond traders at various Wall Street firms who typically must pay a spread of up to 10 basis points to short a specific Treasury bond.<sup>11</sup>

Turning to the valuation methodology, our approach is as follows. For each month of the sample period, we first construct discount curves from both Treasury and swap market data. For the Treasury discount curve, we use the data for the constant maturity six-month, one-year, two-year, three-year, five-year, seven-year, and ten-year CMT rates from the Federal Reserve. We then use a standard cubic spline

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<sup>10</sup>It is becoming increasingly common for investors to require that a hedge fund be terminated or liquidated if its value declines by more than, say, 20 percent.

<sup>11</sup>In some situations, a Treasury bond can trade special in the sense that the cost of shorting the bond can increase to 50 or 100 basis points or more temporarily; see Duffie (1996), Duffie, Garleanu, and Pedersen (2002), and Krishnamurthy (2002). The effect of special repo rates on the analysis would be to reduce the total excess return from the strategy slightly. For example, if an on-the-run Treasury bond were to trade 100 basis points special for a three-month period, the total excess return from the swap-spread strategy would be reduced by up to 2.50 percent (25 basis points on initial capital of 10). The effect of this would actually be to strengthen our conclusion in the next section that there are no arbitrage-related excess returns from this strategy.

algorithm to interpolate these par rates at semiannual intervals. These par rates are then bootstrapped to provide a discount curve at semiannual intervals. To obtain the value of the discount function at other maturities, we use a straightforward linear interpolation of the corresponding forward rates. In addition, we constrain the three-month point of the discount function to match the three-month Treasury rate. We follow the identical procedure in solving for the swap discount function.

At inception, the value of a position is equal to the amount of initial capital in the margin account. Since we hold fixed the notional amount of swap-spread trades at \$100, this initial amount is \$10. After one month, however, the value of the strategy now equals the sum of the value of the swap based on the current swap curve, the value of the Treasury position based on the current Treasury curve, and the value of the margin account with accrued interest. Net cash flows from the swap and bond positions are assumed to be reinvested in the margin account. We follow the same procedure to value the position at each subsequent month until the strategy converges or the maturity date of the position.

Table 3 reports summary statistics from implementing individual swap-spread trades. To describe the results, it is helpful to walk through a specific example. There are 184 months in the sample. This means that there are 160 possible months in which a two-year trade could be implemented and held until maturity. Of these 160 months, there are 108 months when the absolute difference between the two-year swap spread and the expected average value of  $S_t$  exceeds 10 basis points and the strategy is implemented as either a long or a short strategy. Of these 108 trades, 35 of them are underwater at some point during the two-year life of the trade in the sense that the value of the position is less than the value of the initial capital plus accrued interest. Of the 108 trades, however, only 11 end up with a final overall loss or negative excess return after two years. The mean cumulative excess return for the 108 trades is 3.39 percent, where the minimum and maximum excess returns are  $-2.21$  and  $10.96$  percent, respectively. Since some trades converge after one month while others do not converge and are held for the entire two years, the trades have different holding periods. Table 3 reports the mean monthly excess return for the trades, where the mean is taken by giving equal weights to months. The mean excess return is 0.24 percent. The minimum and maximum monthly returns for the 108 trades are  $-5.32$  and  $5.21$  percent, respectively. Finally, the maximum percentage drawdown or decline from the initial value of any trade is  $-7.05$  and the mean time the trades are held is 1.17 years. Similar interpretations hold for all of the other strategies reported in Table 3.

A number of interesting insights about this fixed income arbitrage strategy emerge from Table 3. First, consistent with Figure 2, the results show that there are frequently differences between swap spreads and the expected average short-term spread large enough to trigger the swap-spread strategy. Even when the trigger is 30 basis points, the strategy is implemented for 16 to 48 percent of the possible months during the

sample period. Second, these results indicate that the swap-spread strategy is not an arbitrage in the pure textbook sense; a small percent of the trades do in fact end up with cumulative losses or negative excess returns. On the other hand, the total excess returns from the trades are overwhelmingly positive. The percentage of positive total excess returns ranges from 90 to 100 percent across the different strategies. Third, the average total excess returns from the trades are all positive and often large in magnitude. For example, when a 10 basis point trigger is used, average total excess returns range from 3.39 percent for the two-year strategy, to 27.31 percent for the 10-year strategy. Fourth, even when there is a loss, the loss is relatively modest. In particular, the worst total excess return experienced by any trade is  $-2.21$  percent. Fifth, the average monthly excess returns from the trades are all positive, ranging from 0.24 to 0.82 percent. The results show, however, that the monthly returns can be volatile; monthly returns range from  $-11.12$  to 12.58 percent. Intuitively, the reason for this volatility stems from the mark-to-market variation in the value of the trade. Thus, even if a trade were certain to have a positive total excess return over its life, there might well be months where the trade experiences losses as swap and Treasury rates vary through time. Ultimately, the effects of mark-to-market variation in the value of a trade net out since the final value of the trade is determined entirely by the actual cash flows received over the life of the trade. Finally, Table 3 shows that even though most trades ultimately generate positive excess returns, many of the trades are underwater at some point during the life of the trade. For example, the ten-year strategy never results in an overall loss. Despite this, the maximum drawdown for the ten-year trades is  $-13.31$  percent. Thus, trades that are ultimately profitable can experience large negative intermediate returns before they finally converge.<sup>12</sup>

## 5. FIXED INCOME ARBITRAGE RISK AND RETURN

In this section, we study the risk and return characteristics of fixed income arbitrage. As in Mitchell and Pulvino (2001), we first construct a fixed income arbitrage return index based on following a specific portfolio strategy over time. We examine the properties of the resulting returns during the sample period. We then explore whether the excess returns generated by the fixed income arbitrage strategies represent compensation for exposure to systematic market factors.

### 5.1 Constructing the Index.

To study the characteristics of fixed income arbitrage returns, we first construct an index of returns generated by following a simple portfolio strategy over time. In this strategy, we invest in an equally-weighted portfolio of swap-spread trades, where each trade employs the same ten to one leverage, and rebalance monthly. For clarity, we

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<sup>12</sup>This result is consistent with the theoretical model of arbitrage presented in Liu and Longstaff (2004).

describe how the index is constructed for the specific case of the two-year swap-spread strategy; the procedure for the other strategies is virtually identical.

Assume that each month, a (hypothetical) new hedge fund is proposed. If the two-year swap-spread strategy is attractive, then the hedge fund is funded and the strategy implemented, in which case, the hedge fund exists until either the strategy converges, or the two-year horizon is reached. We assume that if the strategy is implemented, it is the only trade the hedge fund puts on. Thus, at the beginning of the first month, an arbitrageur will either have zero hedge funds to invest in, if the two-year trade is not attractive, or one if the strategy is attractive. If zero, the arbitrageur puts his capital into a margin account and earns zero excess return for the first month. If one, then the arbitrageur puts his capital into the hedge fund and his excess return is the excess return on the hedge fund for the first month, or equivalently, the excess return on the two-year trade for that month (since the hedge fund has only the one trade).

At the beginning of the second month, a new hedge fund is proposed. If the two-year strategy is attractive, then this new hedge fund comes into existence and implements the trade. Thus, at the beginning of the second month, an arbitrageur will either have zero, one, or two hedge funds to invest in. There will be zero funds if the first month's hedge fund was either not implemented, or if the trade converged after one month, and the two-year trade is currently not attractive. There will be one hedge fund if either the first month's hedge fund was not implemented but the second month's hedge is implemented, or the first month's hedge fund was implemented but has not yet converged and the second month's hedge fund is not implemented. There will be two hedge funds if both the first and second months' hedge funds are implemented and the first has not yet converged. If there are zero hedge funds available, then the arbitrageur places all of his capital into the margin account and earns zero excess return. If there are hedge funds available, then the arbitrageur places an equal amount of his capital into the available hedge funds. In this case, his return for the month is just an equally-weighted average of the returns for the available hedge funds at the beginning of the second month.

This process continues for each month throughout the sample period. In some periods, there may be as many as 24 different hedge funds available to invest in. At other times, all of the previously implemented hedge funds may have converged and the two-year strategy may not be currently attractive. In this case, there will be zero hedge funds available for investment and the arbitrageur will have an excess return of zero for that month. Each month, the arbitrageur places an equal amount of his capital in the available hedge funds and his return for the month is an equally-weighted average of the returns on all available hedge funds. Clearly, this equally-weighted portfolio can also be viewed as the returns from a fund of hedge funds.<sup>13</sup> We follow

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<sup>13</sup>Since the returns from these hedge funds are all highly correlated, there is little difference between returns based on an equal weighting or on a value weighting.

the same procedure to construct return series for the three-year, five-year, and ten-year strategies.

## 5.2 Fixed Income Arbitrage Returns.

Table 4 reports summary statistics for the return indexes constructed for the various trade trigger levels and strategy horizons. As shown, all of the trading strategies result in positive average monthly excess returns. These average excess returns range from 0.10 to 0.49 percent per month, annualizing to values of about one to six percent. In general, these excess returns are somewhat smaller than those shown for the individual trades in Table 3. The reason for the difference is that there are months in which there are no hedge funds in which to invest, resulting in a zero excess return for that month. In contrast, Table 3 reports the excess returns conditional on a trade occurring. Thus, the excess returns reported in Table 4 depend not only on how profitable individual swap-spread trades are, but also on how frequently profitable trading opportunities are available.

Table 4 also reports the volatility in the returns. The standard deviations for the two-year strategy are on the order of one percent per month, while the standard deviations for the ten-year strategy are roughly four percent per month. The variation in the returns is also clear from the differences between the minimum and maximum returns during the sample period. Interestingly, the fixed income arbitrage return indexes display some degree of mean reversion. In particular, the first-order serial correlation for the indexes range from about zero to  $-0.22$ .

Table 4 also reports the annualized Sharpe ratios for the various swap-spread strategies. The Sharpe ratios for the two-year and three-year strategies are the highest with values in the range of 0.44 to 0.72. Intuitively, this may be due to the fact that these strategies provide more frequent trading opportunities. Furthermore, these trades converge more rapidly since they have shorter horizons. In general, however, all of the swap-spread strategies appear to offer attractive Sharpe ratios to investors.

## 5.3 Are Excess Returns Compensation for Risk?

Since the swap-spread strategy consists of a long position in a swap and an offsetting short position in a Treasury bond with the same maturity (or vice versa), this strategy is often viewed as market neutral. In actuality, however, this strategy is subject to the risk of a major widening in the Treasury-repo spread. If this risk is correlated with market factors, then the excess returns reported in Table 4 may in fact represent compensation for the underlying market risk of this strategy.

To examine this issue, we regress the excess returns for the strategies on the excess returns of a number of market factors. To control for equity market risk, we use the excess returns on the CRSP value-weighted market index (data provided courtesy of Ken French) and on the S&P bank stock index (from the Bloomberg system).<sup>14</sup>

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<sup>14</sup>We also estimated the regressions using the Fama-French (1993) SMB and HML

To control for bond market risk, we use the excess returns on the CRSP Fama two-year, five-year, and ten-year Treasury bond portfolios. Finally, as another control for banking sector risk, we use the excess returns on the Merrill Lynch investment-grade index for bonds issued by banks (also obtained from the Bloomberg system). The regression results are reported in Table 5.

Table 5 shows that the alphas for the fixed income arbitrage strategies are all much smaller in magnitude than the mean excess returns reported in Table 4. In addition, none of the alphas from these regressions are statistically significant even at the ten percent level.

Surprisingly, many of the strategies appear to have some degree of market risk. In particular, the market excess return is significant at roughly the ten percent level for six of the strategies. This result may seem counterintuitive given that we are studying pure fixed income strategies. Previous research by Campbell (1987), Fama and French (1993), Campbell and Taksler (2002) and others, however, documents that there are common factors driving returns in both bond and stock markets. Our results show that the same is also true for this fixed income arbitrage hedge fund strategy. The slope coefficient (which can be interpreted as a beta) for the ten-year strategy can be as high as 0.168.

The excess return for the bank stock index has a uniformly negative slope coefficient, and is significant at the ten percent level for each of the five-year and ten-year strategies. This suggests that fixed income arbitrage returns have both banking industry and marketwide equity risk components that are priced by the market.

The excess returns on the Treasury bonds are often significant, although the pattern varies across the different strategy horizons. For the two-year and three-year strategies, the pattern for the slope coefficients is always positive, negative, and positive, suggesting that the interest rate exposure of the strategies is similar to that of a bond convexity or butterfly trade. The excess return on the two-year Treasury portfolio is significant at or near the ten percent level for four of the strategies. Similarly, the excess return of the five-year Treasury portfolio is significant at the ten percent level for eight of the strategies, while the excess return of the ten-year Treasury portfolio is significant for three of the strategies.

Finally, the excess returns for the bank bond portfolio are significant at the ten percent level for each of the strategies shown in Table 5. The sign of the relation is uniformly positive, and the  $t$ -statistics are often on the order of four to five. The  $R^2$  for the regressions range from about 7 to 19 percent.

In summary, these results provide a number of interesting insights into the economics of this popular fixed income arbitrage strategy. First, the excess returns gen-

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factors, as well as the UMB momentum factors. We omit these regressions from the reported results since the SMB, HML, and UMB factors were never significant.



erated by the strategy appear to be almost exclusively compensation for the market risk of the strategy; there is little or no “arbitrage” component to this fixed income arbitrage strategy. Second, the swap-spread strategy has exposure to a wide array of priced risks. In particular, the strategy has exposure to the stock market, the banking industry, the Treasury bond market, and the corporate bond market. These results are consistent with the view that the financial sector plays a central role in asset pricing. In particular, the swap-spread strategy has direct exposure to the risk of a financial sector event or crisis. The commonality in returns, however, suggests that both the stock, Treasury, and corporate bond markets have exposure to the same risk. Thus, financial-event risk may be an important source of the commonality in returns across different types of securities.

## 6. HISTORICAL HEDGE FUND RETURNS

We have focused on return indexes generated by following specific fixed income arbitrage strategies over time rather than on the actual returns reported by hedge funds. As discussed earlier, there are a variety of important reasons for adopting this approach, including avoiding survivorship biases, holding leverage fixed in the analysis, etc. To provide additional perspective, however, we repeat our analysis using actual fixed income arbitrage hedge fund return data from several widely-cited industry sources.

In particular, we obtain monthly return data from Credit Suisse First Boston (CSFB)/Tremont Index LLC for the HEDG Fixed Income Arbitrage Index. The underlying data for this index is based on the TASS database. The sample period for this data is January 1994 to December 2003. To be included in the index, funds must have a track record in the TASS database of at least one year, have an audited financial statement, and have at least \$10 million in assets.<sup>15</sup> This index is a value-weighted index. The TASS database includes data on more than 4,500 hedge funds.

We also obtained monthly return data for the HFRI Fixed Income Arbitrage Index. Although returns dating back to 1990 are provided, we only use returns for the same period as for the CSFB/Tremont Index to insure comparability and to minimize survivorship biases. This index is fund or equally weighted, has no minimum fund size for inclusion in the index, and has no required length of time for inclusion of a fund in the HFRI index. This data source tracks approximately 1,500 hedge funds.

The properties of the fixed income arbitrage hedge fund returns implied by these industry sources are very similar to those for the return indexes described in the previous section. In particular, the annualized average return and standard deviation of the CSFB/Tremont Fixed Income Arbitrage Index returns are 6.80 and 3.95 percent,

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<sup>15</sup>See Credit Suisse First Boston (2002) for a discussion of the index construction rules.

respectively (excess return 2.70 percent). These values imply a Sharpe ratio of about 0.68 (which is close to the Sharpe ratio of 0.63 reported by Tremont/TASS (2003)). The annualized average return and standard deviation for the HFRI Fixed Income Arbitrage Index are 5.93 and 4.21 percent, respectively (excess return 1.82 percent). These values imply a Sharpe ratio of 0.43, which closely parallels the values shown in Table 4 for the return indexes. Although the correlations between the CSFB/Tremont and HFRI indexes and our return indexes vary across strategies, these correlations are typically in the range of 0.10 to 0.30. Thus, while the correlation is far from perfect, there is a significant degree of correlation between our return indexes and those based on reported hedge fund return data. Furthermore, these correlations are similar to the correlation of 0.36 reported by Mitchell and Pulvino (2001) between their return index and merger arbitrage returns reported by industry sources.<sup>16</sup>

Table 6 reports the results from the regression of the excess returns from the two indexes on the vector of excess returns described in the previous section. As shown, the results are very similar to those reported in Table 5. In particular, neither of the alphas for the indexes are significant. For the CSFB/Tremont Index, the alpha is about 12 basis points per month; for the HFRI Index, the alpha is about 14 basis points per month.

In each case, the market beta is slightly negative, but not significant. Similarly, the excess returns from bank equity are negatively related, but again not significant. For the CSFB/Tremont Index, the excess returns for the Treasury bond portfolios again show the same positive, negative, positive pattern that is common in Table 5. The *t*-statistic for the five-year Treasury portfolio is highly significant. A similar, but less significant pattern holds for the HFRI index. Finally, the excess return for the Merrill Lynch Index of investment-grade bank bonds is highly significant for the CSFB/Tremont Index with a *t*-statistic in excess of four, and significant at the ten percent level for the HFRI Index. The similarity of these results to those reported earlier provides strong support for the robustness of the analysis.

## 7. CONCLUSION

This paper explores the risk and return characteristics of fixed income arbitrage. Paralleling Mitchell and Pulvino (2001), we construct indexes of returns from following a widely-used arbitrage strategy based on swap spreads.

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<sup>16</sup>In addition to returns generated by swap-spread arbitrage, actual fixed income hedge fund returns typically include returns from other strategies such as mortgage arbitrage, yield curve arbitrage, or interest volatility arbitrage. Also, actual hedge funds use varying amounts of leverage. These factors may play a role in determining the correlations.

The results are intriguing. We find that the fixed income arbitrage strategies have sizable positive excess returns. These excess returns range from one to six percent per year depending on the horizon of the strategy. These values agree well with the excess returns for fixed income arbitrage hedge funds reported by industry sources. We examine whether these excess returns represent compensation for the market risk of the strategy. We find that virtually all of these excess returns are related to market risk; none of the alphas for the strategies are significant after controlling for risk. This is true not only for our return indexes, but also for reported returns for actual fixed income arbitrage hedge funds.

We also show that the excess returns for these fixed income arbitrage strategies are related to excess returns for the stock market, excess returns for bank stocks, and excess returns for Treasury and corporate bonds. This suggests that the risk of a major financial event or crisis is a risk that is priced throughout many financial markets. Thus, financial-event risk may be one important source of the widely-documented commonalities in risk premia across different asset classes.

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Table 1

**Cash Flows from the Swap-Spread Arbitrage Strategy.** This table illustrates the cash flows generated by a stylized form of the swap-spread arbitrage strategy.  $CMS$  and  $CMT$  denote the fixed swap and Treasury coupon rates.  $L_t$  denotes the Libor rate determined at time  $t$ , and  $r_t$  denotes the repo rate determined at time  $t$ . By market convention, floating rates paid at time  $t$  are set or determined at time  $t - 1$ .  $SS$  denotes the swap spread and equals  $CMS - CMT$ . The term  $S_t$  denotes the difference  $L_t - r_t$ . For expositional simplicity, this table assumes that floating and fixed cash flows are paid each period.

Strategy	Cash Flow at Time						
	0	1	2	3	4	...	$T$
Receive Fixed Swap Rate	0	$CMS$	$CMS$	$CMS$	$CMS$	...	$CMS$
Pay Libor Rate on Swap	0	$-L_0$	$-L_1$	$-L_2$	$-L_3$	...	$-L_{T-1}$
Short Bond, Pay Coupons	+100	$-CMT$	$-CMT$	$-CMT$	$-CMT$	...	$-CMT - 100$
Receive Repo Rate on Margin Acct.	-100	$r_0$	$r_1$	$r_2$	$r_3$	...	$r_{T-1} + 100$
Total	0	$SS - S_0$	$SS - S_1$	$SS - S_2$	$SS - S_3$	...	$SS - S_{T-1}$

**Table 2**

**Summary Statistics for the Spreads.** This table reports summary statistics for the indicated spreads. The spreads are in basis points. The data consist of monthly observations from November 1988 to February 2004.

Spread	Mean	Standard Deviation	Minimum	Median	Maximum	Serial Correlation	<i>N</i>
Libor – Repo Spread	27.3	13.4	1.0	25.1	83.8	0.67	184
2-Year Swap Spread	37.6	18.7	10.0	34.8	86.0	0.91	184
3-Year Swap Spread	44.8	19.9	12.0	42.8	91.6	0.92	184
5-Year Swap Spread	49.5	22.8	15.0	43.8	111.3	0.94	184
10-Year Swap Spread	56.8	24.8	15.5	50.5	134.1	0.95	184



Table 3

**Summary Statistics for the Individual Trades.** This table reports the indicated summary statistics for the individual trades. Trade trigger indicates the number of basis points by which the swap spread must differ from the expected average value of the Libor-repo spread before a trade is initiated. Strategy horizon is the horizon date of the underlying swap and bond. Poss. equals 184 minus the horizon of the trade (in months) and denotes the maximum possible number of trades that could have been initiated and held to final maturity during the sample period. Actual is the actual number of trades, that is, number of times the strategy meets the trade trigger and is implemented. Underwater is the number of trades where the value of the position is less than its inception value at some point during the life of the trade. Loss denotes the number of trades where the total excess return over the life of the trade is negative. Drawdown is the maximum percentage difference between the value of a trade during its life and the initial value of the trade; the drawdown reported is the maximum taken over all trades. Time to convrg. is the mean time in years between the initiation of a trade and its convergence or expiration, where the mean is taken over all trades.

Trade Trigger	Strategy Horizon	Number of Trades			Total Excess Return			Monthly Excess Return			Draw-down	Time Cnvrng.	
		Poss.	Actual	Under-water	Loss	Mean	Min.	Max.	Mean	Min.			Max.
10 bp	2 yr	160	108	35	11	3.39	-2.21	10.96	0.24	-5.32	5.21	-7.05	1.17
	3 yr	148	89	36	9	6.51	-2.05	18.05	0.31	-4.92	7.34	-4.96	1.77
	5 yr	124	62	32	0	12.07	1.55	21.41	0.44	-11.12	8.31	-14.41	2.31
	10 yr	64	42	25	0	27.31	6.67	44.76	0.82	-9.66	12.58	-13.31	2.65
20 bp	2 yr	160	61	17	1	4.62	-0.14	10.96	0.30	-5.32	5.21	-4.36	1.28
	3 yr	148	67	26	0	7.96	2.21	18.05	0.36	-4.92	7.34	-4.96	1.83
	5 yr	124	47	21	0	14.69	5.58	21.41	0.55	-8.20	8.31	-9.67	2.22
	10 yr	64	39	24	0	28.58	13.89	44.76	0.82	-9.66	12.58	-12.86	2.77
30 bp	2 yr	160	25	4	0	7.31	2.80	10.96	0.50	-3.64	5.21	-3.14	1.20
	3 yr	148	47	12	0	9.24	3.05	18.05	0.40	-4.92	6.73	-4.44	1.89
	5 yr	124	36	13	0	16.29	7.62	21.41	0.54	-6.96	8.31	-6.32	2.45
	10 yr	64	31	18	0	31.18	18.75	44.76	0.82	-9.66	12.58	-11.42	3.00

Table 4

**Summary Statistics for Monthly Fixed Income Arbitrage Index Returns.** This table reports the indicated summary statistics for monthly index returns. The index consists of monthly returns on an equally-weighted portfolio of individual hedge funds and is rebalanced monthly. The number of hedge funds available each month varies depending of whether existing funds have converged or matured. Transaction costs of initiating and exiting trades are included.

Trade Trigger	Strategy Horizon	Mean Number of Funds	Monthly Excess Return					Sharpe Ratio
			Mean	Min.	Max.	Std. Dev.	Serial Corr.	
10 bp	2 yr	8.48	0.19	-4.29	3.49	1.01	-0.02	0.65
	3 yr	12.25	0.29	-4.52	6.35	1.42	-0.21	0.72
	5 yr	17.23	0.32	-9.89	6.18	2.22	-0.08	0.51
	10 yr	24.53	0.47	-16.35	15.81	4.47	-0.16	0.36
20 bp	2 yr	5.13	0.10	-4.49	3.52	0.88	0.03	0.38
	3 yr	9.25	0.20	-4.52	6.35	1.24	-0.21	0.56
	5 yr	14.16	0.24	-8.20	6.65	2.14	-0.11	0.39
	10 yr	20.11	0.49	-16.41	16.29	4.32	-0.12	0.39
30 bp	2 yr	1.96	0.10	-2.82	4.24	0.80	-0.00	0.44
	3 yr	6.73	0.19	-4.58	5.86	1.21	-0.22	0.55
	5 yr	12.48	0.26	-6.68	6.80	2.04	-0.15	0.43
	10 yr	16.17	0.49	-16.36	15.95	4.04	-0.14	0.42

Table 5

**Regression Results.** This table reports summary statistics from the regression of monthly excess returns for the fixed income arbitrage strategies on the indicated excess returns.  $R_{Mt}$  denotes the excess return on the CRSP value-weighted index;  $R_{St}$  denotes the excess return on the S&P 500 Stock Index. The terms  $R_{2t}$ ,  $R_{5t}$ , and  $R_{10t}$  denote the excess returns on the Fama CRSP bond portfolios with maturities of 2 years, 5 years, and greater than 10 years, respectively.  $R_{Bt}$  denotes the excess return on the Merrill Lynch Index of bonds issued by investment grade banks.

$$R_{it} = \alpha + \beta_1 R_{Mt} + \beta_2 R_{St} + \beta_3 R_{2t} + \beta_4 R_{5t} + \beta_5 R_{10t} + \beta_6 R_{Bt} + \epsilon_t$$

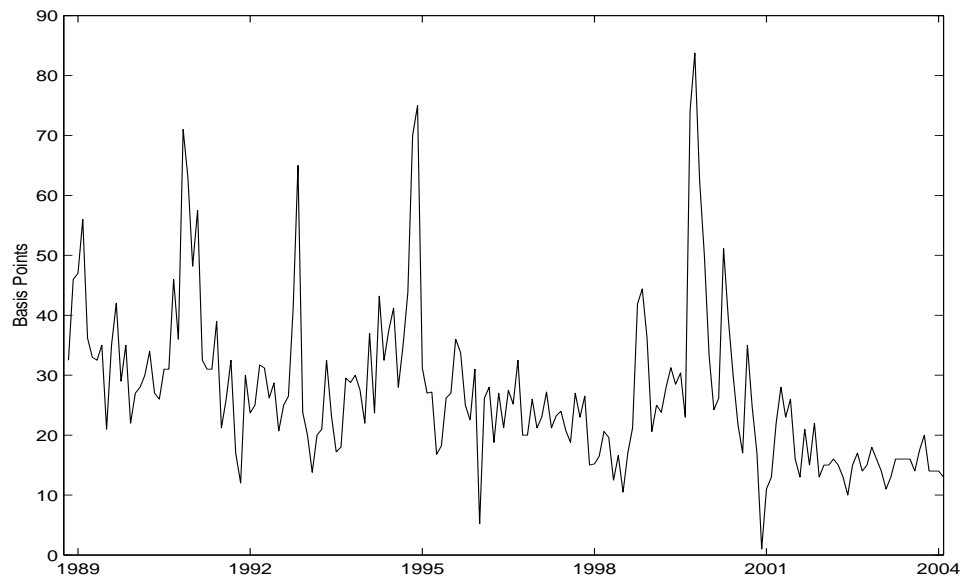
Trade Trigger	Strategy Horizon	Regression Coefficients						$t$ Statistics						$R^2$		
		$\alpha$	$R_M$	$R_S$	$R_2$	$R_5$	$R_{10}$	$R_B$	$\alpha$	$R_M$	$R_S$	$R_2$	$R_5$		$R_{10}$	$R_B$
10 bp	2 yr	0.071	0.024	-0.006	1.126	-0.737	0.107	0.253	0.86	1.04	-0.36	2.11	-2.35	1.10	1.66	0.074
	3 yr	0.175	0.030	-0.032	0.311	-0.634	0.035	0.654	1.54	0.95	-1.50	0.42	-1.48	0.26	3.13	0.085
	5 yr	0.121	0.054	-0.060	1.044	-1.514	-0.272	1.609	0.71	1.12	-1.84	0.94	-2.33	-1.34	5.09	0.159
	10 yr	0.045	0.168	-0.135	1.101	-0.698	-1.537	3.056	0.13	1.76	-2.07	0.50	-0.54	-3.81	4.84	0.179
20 bp	2 yr	-0.045	0.023	-0.015	1.331	-0.824	0.119	0.293	-0.64	1.17	-1.13	2.95	-3.10	1.43	2.27	0.122
	3 yr	0.062	0.041	-0.029	0.976	-0.860	0.096	0.492	0.62	1.46	-1.51	1.51	-2.27	0.82	2.66	0.090
	5 yr	0.007	0.074	-0.072	1.109	-1.594	-0.234	1.667	0.04	1.63	-2.30	1.05	-2.58	-1.22	5.54	0.186
	10 yr	0.075	0.158	-0.131	0.381	-0.425	-1.538	3.149	0.23	1.71	-2.08	0.18	-0.34	-3.96	5.18	0.186
30 bp	2 yr	-0.010	0.031	-0.014	0.734	-0.410	0.009	0.269	-0.15	1.75	-1.14	1.78	-1.69	0.12	2.28	0.102
	3 yr	0.053	0.045	-0.030	1.015	-0.817	0.086	0.459	0.54	1.64	-1.60	1.60	-2.20	0.74	2.53	0.089
	5 yr	0.042	0.050	-0.088	1.444	-1.589	-0.140	1.435	0.26	1.13	-2.88	1.41	-2.64	-0.75	4.90	0.150
	10 yr	0.117	0.144	-0.166	0.431	-0.089	-1.375	2.649	0.37	1.64	-2.77	0.21	-0.08	-3.72	4.58	0.161

Table 6

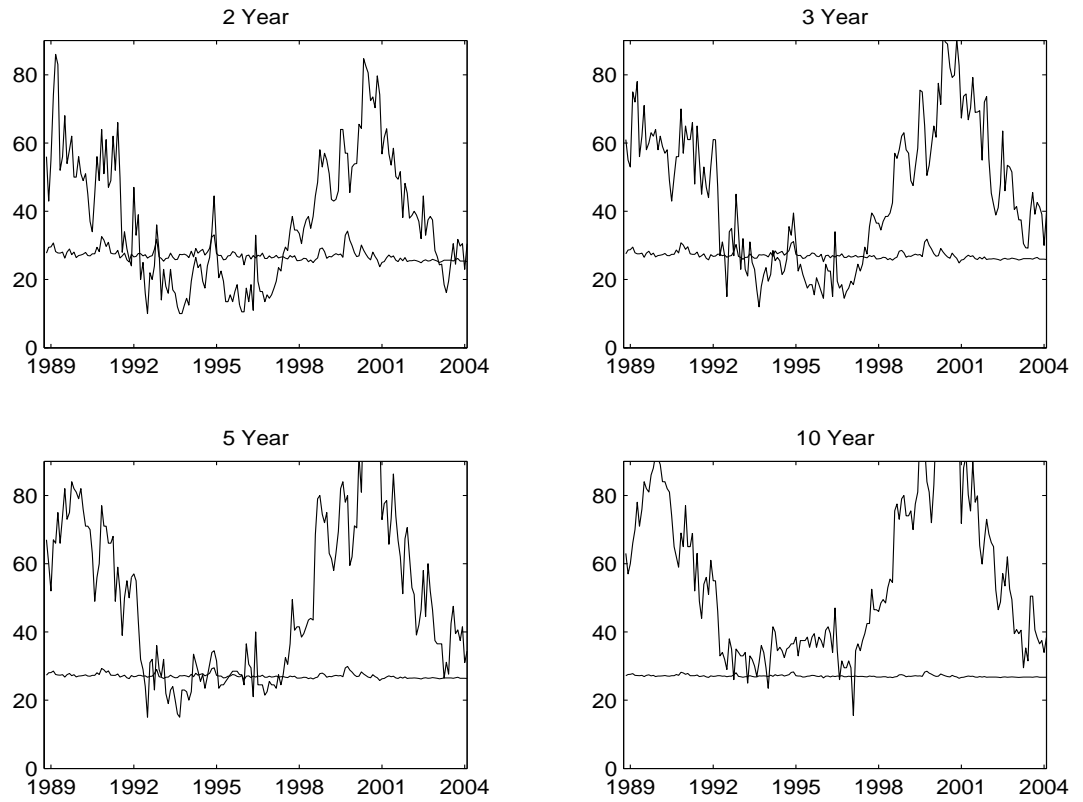
**Regression Results.** This table reports summary statistics from the regression of monthly excess returns for the fixed income arbitrage strategies on the indicated excess returns.  $R_{Mt}$  denotes the excess return on the CRSP value-weighted index;  $R_{St}$  denotes the excess return on the S&P Bank Stock Index. The terms  $R_{2t}$ ,  $R_{5t}$ , and  $R_{10t}$  denote the excess returns on the Fama CRSP bond portfolios with maturities of 2 years, 5 years, and greater than 10 years, respectively.  $R_{Bt}$  denotes the excess return on the Merrill Lynch Index of bonds issued by investment grade banks.

$$R_{it} = \alpha + \beta_1 R_{Mt} + \beta_2 R_{St} + \beta_3 R_{2t} + \beta_4 R_{5t} + \beta_5 R_{10t} + \beta_6 R_{Bt} + \epsilon_t$$

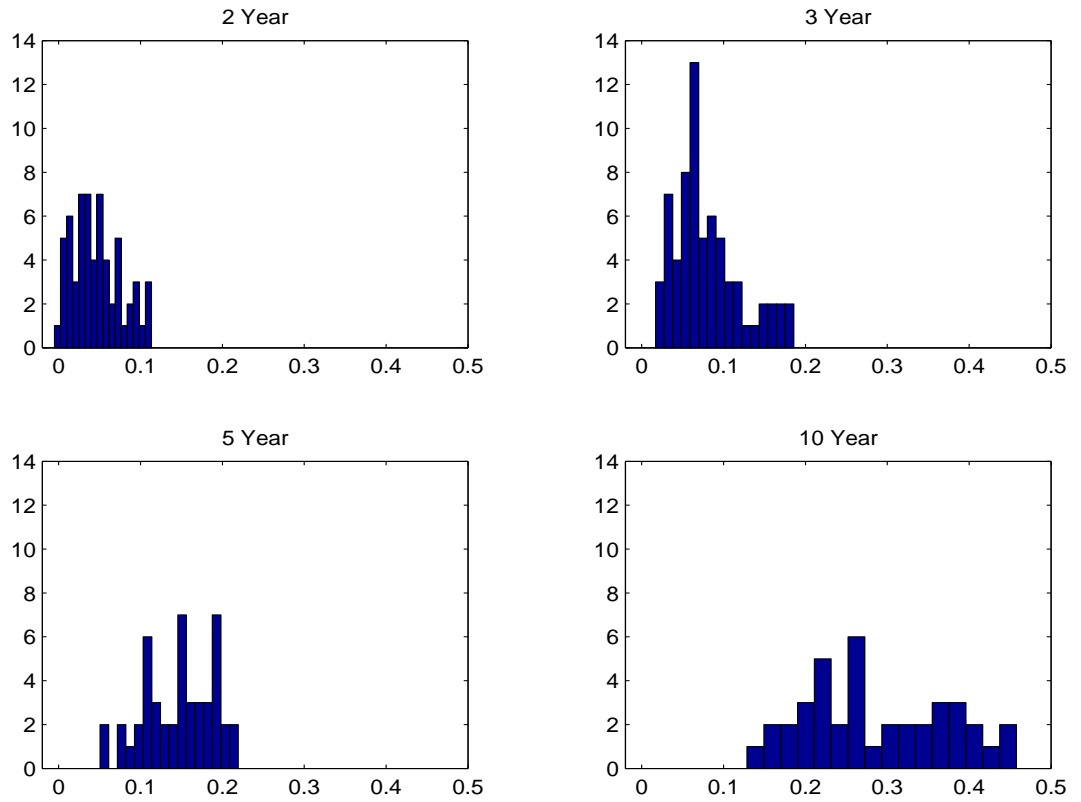
	Regression Coefficients						t Statistics						$R^2$		
	$\alpha$	$R_M$	$R_S$	$R_2$	$R_5$	$R_{10}$	$R_B$	$\alpha$	$R_M$	$R_S$	$R_2$	$R_5$		$R_{10}$	$R_B$
CSFB/Trem. FI Arb Indx.	0.124	-0.031	-0.006	0.266	-1.039	0.063	0.923	1.19	-1.12	-0.33	0.38	-2.67	0.48	4.08	0.189
HFRI FI Arb Indx.	0.145	-0.046	-0.009	0.359	-0.680	-0.010	0.473	1.18	-1.43	-0.40	0.44	-1.49	-0.06	1.79	0.055



**Figure 1. The Libor-Repo Spread.** This graph plots the spread between the three-month Libor and general collateral repo rates.



**Figure 2. Swap Spreads and Expected Average Libor-Repo Spreads.** These graphs plot the expected average value of the Libor-repo spread and the corresponding swap spread for the indicated horizons. All spreads are in basis points.



**Figure 3. Histograms of Total Excess Returns.** These graphs plot the distribution of total excess returns for the indicated horizons. Excess returns are measured as percentages. Results shown are for the case where the trade trigger is 20 basis points.