Embedded Leverage

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Abstract.

Many financial instruments are designed with embedded leverage such as options and leveraged exchange traded funds (ETFs). Embedded leverage alleviates investors' leverage constraints and, therefore, we hypothesize that embedded leverage lowers required returns. Consistent with this hypothesis, we find that asset classes with embedded leverage offer low risk-adjusted returns and, in the cross-section, higher embedded leverage is associated with lower returns. A portfolio which is long low-embedded-leverage securities and short high-embedded-leverage securities earns large abnormal returns, with t-statistics of 8.6 for equity options, 6.3 for index options, and 2.5 for ETFs. We provide extensive robustness tests and discuss the broader implications of embedded leverage for financial economics.

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We propose that an important feature of a financial instrument is its *embedded leverage*, that is, the amount of market exposure per unit of committed capital. The importance of embedded leverage arises from investors' inability (or unwillingness) to use enough outright leverage to get the market exposures they would like. For instance, individual investors and pension funds may not be able to use any leverage, banks face regulatory capital constraints, and hedge funds must satisfy their margin requirements. However, an investor can gain substantial market exposure without using outright leverage by buying options, leveraged ETFs, or other securities that *embed* the leverage. In fact, many of these securities are designed precisely to provide embedded leverage.

Buying securities that embeds leverage increases market exposure without violating leverage constraints, without risking a loss of more than 100%, and without a need for dynamic rebalancing (as opposed to borrowing money for outright leverage). Investors are therefore willing to pay a premium for securities with embedded leverage and intermediaries who meet this demand need to be compensated for their risk.

We find strong evidence that embedded leverage is associated with lower required returns: (1) Looking at the overall return of asset classes with embedded leverage, we find that such asset classes offer low risk-adjusted returns; (2) In each of the cross-sections of equity options, index options, and ETFs, securities with more embedded leverage offer lower risk-adjusted returns; (3) For each asset class, we consider betting-against-beta (BAB) portfolios which are long low-embedded-leverage securities and short high-embedded-leverage securities, constructed to be market neutral and neutral to each of the underlying securities. These BAB portfolios earn large and statistically significant abnormal returns with Sharpe ratios in excess of 1 and large t-statistics; (4) In contrast to prior work on options focused on S&P500 index options, our portfolios are statistically well behaved with skewness and kurtosis in line with those of standard risk factors since we diversify across 12 indices and about 3000 equities, respectively, include a large number of long and short option positions (value-weighted) for each underlying, apply daily hedges, and rebalance portfolios to keep a constant risk profile.

To test our hypotheses, we must first formally define a security's embedded leverage. The embedded leverage, which we denote by omega Ω, of a derivative security with price F with respect to exposure to underlying asset S is given by

$$\Omega = \left|\frac{\partial F}{\partial S} S/F\right| = |\Delta S/F| \tag{1}$$

where $\Delta = \partial F/\partial S$ is the security's delta. In other words, a security's embedded leverage is its percentage change in price for a one percentage change in the underlying. Hence, a security's embedded leverage measures its return magnification relative to the return of the underlying. We take the absolute value since investors' capital constraints can alleviated both by return magnification on the long and short sides (see Appendix B for details). The name omega is taken from the option literature where this definition is usually referred to as the option elasticity (no standard notation exists, however, as some references use other symbols such as lambda). Another justification of the name omega comes from the X-Men stories in which the omega symbol is identified with powerful mutants, just like securities with embedded leverage are powerful mutants of the underlying securities.

For a leveraged ETF, computing omega is straightforward. For instance, the embedded leverage of a 2-times S&P500 is naturally 2. It is also straightforward to compute the embedded leverage for options as it only relies on the standard delta Δ and the option price. Equity options typically have embedded leverage between 2 and 20, with larger embedded leverage for short-dated options that are out of the money.[1] Index options tend to have yet larger embedded leverage, often ranging from 3 to 40. For instance, if an index is at $100 and has a volatility of 15%, then a 1-month option with strike price 100 has a Black-Scholes-Merton price of $1.9. If the index goes up 1% to 101, then the option value increases to $2.5, which is 31% increase, ($2.5-$1.9)/$1.9=31%. This is clearly a dramatic magnification of returns.

The significant amount of dispersion in embedded leverage across securities with similar fundamental exposure allows us to directly test our hypothesis that leverage aversion affects required returns. We consider three different samples. We consider a rich dataset of equity options and index options from 1996 to 2010 using OptionMetrics. The sample of equity options consists of nearly 3000 underlying equities per year with 62 options per stock-month on average. The sample of index options contains 12 different indices with 371

[1] We show this monotonicity of embedded leverage with respect to moneyness and time to maturity empirically in Table III, but it is related to analytical results for European options in Borell (1999, 2002) and for American options in Ekström and Tysk (2006).

options per index on average. We hand-collect the sample of leveraged ETFs and unleveraged counterparts from Yahoo finance from 2006 to 2010. Each of these samples provides strong evidence consistent with our hypothesis as detailed above.

Our results relate to several literatures. Foremost, our tests are directly based on the theory of leverage constraints (Black (1972, 1992), Frazzini and Pedersen (2010)). Frazzini and Pedersen (2010) show theoretically that a "Betting Against Beta" (BAB) portfolio should earn a positive expected return when some investors face leverage constraints. A BAB portfolio is a zero-beta self-financing portfolio which goes long low-risk securities and shorts high-risk securities, where the long and short sides are scaled to have equal market exposure. Frazzini and Pedersen (2010) finds consistent empirical evidence within equities, government bonds, corporate bonds, and other asset classes, as higher beta is associated with lower alpha.[2]

While the existing literature studies securities that differ both in the level of risk and in their fundamentals, this paper focuses on securities with different *embedded* leverage, but based on the *same* underlying instrument. This offers a more direct test of the theory of leverage aversion. Importantly, each of the asset classes that we study has been designed – and gained interest – at least in part because of the embedded leverage that it offers. Indeed, embedded leverage is an important driver of option markets (together with volatility exposure) and it is in fact the only reason for the existence of leveraged ETFs. The fact that embedded leverage is the economic driver behind the innovation in these asset classes lends to credence to our finding that embedded leverage affects required returns, makes data-mining concerns less severe, and has broader implications for financial economics. Our findings suggest that embedded leverage is a driver of asset prices, providing a novel perspective on derivative pricing. Further, our results suggest that embedded leverage is a

[2] This evidence complements the large literature documenting that the standard CAPM is empirically violated for equities (Black, Jensen, and Scholes (1972), Gibbons (1982), Kandel (1984), Shanken (1985), Karceski (2002)) and across asset classes (Asness, Frazzini, and Pedersen (2012)). Also, stocks with high idiosyncratic volatility have realized low returns (Falkenstein (1994), Ang, Hodrick, Xing, Zhang (2006, 2009)) though this effect disappears when controlling for the maximum daily return over the past month (Bali, Cakici, and Whitelaw (2010)) and when using other measures of idiosyncratic volatility (Fu (2009)). More broadly, leverage and margin constraints can explain deviations from the Law of One Price (Garleanu and Pedersen (2009)), the effects of central banks' lending facilities (Ashcraft, Garleanu, and Pedersen (2010)), and general liquidity dynamics (Brunnermeier and Pedersen (2009)).

force behind security design and the desire for leverage implicitly challenges Modigliani-Miller.

In the option literature, the main puzzle is that index options appear expensive (Rubinstein (1994), Longstaff (1995), Bates (2000), Jackwerth (2000), Coval and Shumway (2001), Bollen and Whaley (2004), Jurek and Stafford (2011)) and, to some extent, equity options (Ni (2006)). Our findings suggest that options' expensiveness can be explained by their embedded leverage.

Our tests are also consistent with the idea that demand pressure affects option prices as intermediaries need compensation for taking unhedgeable risk (Garleanu, Poteshman, and Pedersen (2009)). We show how the demand could arise from a desire for embedded leverage and find consistent price effects in asset classes where intermediaries face non-trivial amounts of unhedgeable risk.[3]

Much of the option literature is focused on S&P500 options, which have very skewed returns (often with monthly returns of –100%) leading to poor statistical properties (Broadie, Johannes, and Chernov (2009)). To address this, we consider portfolios that diversify across options written on 12 different indices and almost 3000 equities, respectively, diversify across strikes and maturities, use value weighing to aggregate options, and apply daily hedging of the underlying securities. Furthermore, as we explain in more detail below, at each rebalance date, both the long and the short leg of our BAB portfolios are de-leveraged and scaled to have an exposure to the underlying security of one. This method keeps the BAB portfolios dynamically risk balanced for two reasons: i) In the time series, the BAB factor for each underlying security is risk balanced since option position sizes are scaled down at times when the options are more volatile due to high embedded leverage; ii) Similarly, this method balances risk when aggregating individual BABs into a portfolio. Based on this methodology, our BAB factors' return distributions don't have the problems highlighted in the literature. In fact, the BAB factors are as well behaved (e.g., similar kurtosis) as standard risk factors such as HML, SMB, and UMD, making standard inference possible.

[3] See also Figlewski (1989) and Santa-Clara and Saretto (2009).

Our extensive evidence on the risk-adjusted return of options across strikes and maturities complements the emerging literature on the determinant of equity option returns that includes Duan and Wei (2009), Goyal and Saretto (2009), Cao and Han (2010), and Vasquez (2011). Leveraged ETFs have also been studied by Jarrow (2010) and Lu, Wang, and Zang (2009) who focus on compounding effects, while we focus on daily returns to study the returns without compounding.

The rest of the paper is organized as follows. Section 1 describes our data sources, methodology, and preliminary evidence. Section 2 presents our evidence that asset class with embedded leverage offer low risk adjusted returns in general, while Sections 3-5 present our main cross-sectional tests that higher embedded leverage is associated with lower returns. Section 3 does this by considering portfolios sorted on embedded leverage, Section 4 performs a regression analysis, and Section 5 contains an extensive robustness analysis. We conclude by discussing broader implications of embedded leverage pricing. The Appendix contains a discussion of margin requirements, shortselling constraints, and additional summary statistics and robustness analysis.

1. Methodology, Data, and Preliminary Evidence

This section first describes the variety of data sources that we use and the cleaned using various filters as we describe in detail below. We also describe how we calculate returns, how portfolios are constructed, and how we adjust for risk. Our summary statistics show how embedded leverage and returns vary with maturity and moneyness, which already yields preliminary evidence on the return-Omega link.

1.1. Option Data and Return Calculation

Our options data include both equity and index options and are drawn from OptionMetrics Ivy DB database. The data cover all U.S. exchange-listed options and includes daily closing bid and ask quotes, open interest, trading volume, implied volatility and option

"Greeks" computed following standard market conventions.[4] OptionMetrics' security price file contains closing prices and returns of the underlying securities. Table I summarizes the sample description, Table II reports summary statistics, and Table A1, A2 and A3 in the appendix provide additional summery statistics.

Our analysis focuses on monthly delta-hedged option returns in excess of the U.S. Treasury Bills rate. Exchange-listed option contracts expire on the Saturday immediately following the third Friday of the expiration month, and we refer to these dates as "rebalance dates." For each option, we compute the return of buying an option on the first trading day following the expiration Saturday (typically a Monday) and holding it to the next expiration date, while delta-hedging daily using the underlying security. We choose this approach (rather than using daily option rebalances, for instance) to make the returns in our empirical tests closer to an implementable strategy. Indeed, keeping option positions constant for a month and dynamically varying the delta hedge is typical among option traders since trading costs tend to be higher for options than the underlying spot markets.

To see exactly how we compute monthly hedged returns, consider two arbitrary rebalance dates $[0,T]$. Starting with \$1 worth of options at time 0, we wish to compute the value of the buy-and-hold option portfolio with daily delta hedges at time T when the positions are unwound. The value of the portfolio at date 0 is given by $V_0 = 1$ and we iteratively compute the value at the following dates as follows. At each generic date t, the value of the portfolio is given by

$$V_t = V_{t-1} + x(F_t - F_{t-1}) - x\,\Delta_{t-1}\, r_t^S\, S_{t-1} + r_t^f (V_{t-1} - xF_{t-1} + x\,\Delta_{t-1}\, S_{t-1}) \quad (2)$$

where F is the option price, S is the spot price, r^S is the daily spot return, r^f is the daily risk free rate, Δ is the option delta, and x is the number of option contracts given by $x = 1/F_0$. Note the lack of time subscript for x since the option position is kept constant, that is, options

[4] U.S. listed equity options are American while index options are European. To compute implied volatilities and the Greeks for American Options, Optionmetrics uses Cox, Ross, and Rubinstein (1979) binomial tree model. Interest rates are derived from LIBOR rates and settlement prices of Chicago Mercantile Exchange Eurodollar futures. The current dividend yield is assumed to remain constant over the life of the option and the security is assumed to pay dividends at specific predetermined times.

are purchased at time 0 and unwound at date T with no intermediate trading. In Equation (2), the term $x(F_t - F_{t-1})$ is the option's price appreciation, $x\,\Delta_{t-1}\, r_t^S\, S_{t-1}$ is the profit or loss from the delta hedge based on the delta from the previous day, and $r_t^f\,(V_{t-1} - xF_{t-1} - x\,\Delta_{t-1}\; S_{t-1})$ is the interest payment in the margin account, which can be positive or negative. Note that we are assuming no financing spread between lending and borrowing rates, no loan fee on short-sale transactions, and option returns are computed from the bid/ask midpoint. The monthly delta-hedged option return can now be computed as

$$R_{[0,T]} = V_T - V_0 = V_T - 1 \tag{3}$$

The monthly delta-hedged return in excess of the risk free rate is given by

$$r_{[0,T]} = R_{[0,T]} - \left(\prod_{t=1}^{T}(1 + r_t^f) - 1\right) \tag{4}$$

Intuitively, the excess return in (4) corresponds to the returns of a self-financing portfolio that borrows \$1 at date 0, purchases \$1 worth of options, overlays a zero-cost delta-hedging strategy rebalanced daily, and unwinds all positions at date *T*. These excess returns $r_{[0,T]}$ are the basis of all our option tests.

We apply several data filters to minimize the impact of recording errors (see also Driessen, Maenhout, and Vilkov (2009) and Goyal and Saretto (2009)). We discard all options with non-standard settlement or non-standard expiration dates. We drop all observations for which the ask price is lower than the bid price , the bid price is equal to zero or the bid-ask spread is lower than the minimum tick size (equal to \$0.05 for option trading below \$3 and \$0.10 in any other case).

In order to be included in our tests, we impose a series of additional portfolio-inclusion filters. All these filters are applied on the portfolio formation date, so that there is no look-head bias. We require options to have positive open interest, and non-missing delta, implied volatility, and spot price. We also drop options violating that basic arbitrage bound of a non-negative "time value" $F - V$ where V is the option "intrinsic value" equal to $MAX(S - X, 0)$ for calls and $MAX(X - S, 0)$ for puts. U.S. listed equity options are

American so, in order to control for early expiration, we drop equity options with a time value $(F - V)/F$ (in percentage of option value) below 5%. A percentage time value close to 0 means that the option's entire market value is close to the intrinsic value so that there is little optionality and, importantly, immediate exercise might be optimal (in which case we do not want to include this option's next period return in the sample). This filter does not impact any of our results. As another control for early exercise, we also report results using only call equity options on non-dividend paying stocks (since early exercise is never optimal for such options).

Finally, to ensure that our results are not driven by outliers, at portfolio formation we also drop options with embedded leverage in the top or bottom 1% of the distribution (for both puts and calls separately). Our final sample includes 11,327,382 equity option-months covering 7,179 stocks, and 290,125 index option-months covering 12 equity indices. The sample period runs from January 1996 to December 2010.

1.2. ETF Data and Return Calculation

Our ETFs data were collected from Yahoo Finance and contains daily returns of exchange-traded funds on seven major U.S. equity indices for which leveraged ETFs exist. For each index, we select an ETF tracking the index and a corresponding leveraged ETF seeking to mimic twice the daily return of the index. Table I reports the ETFs and their tickers, and Table II provides summary statistics.

For all ETF portfolios, we rebalance the positions daily. We do this to avoid any mismatch or compounding effects. Specifically, a leveraged ETF seeks to replicate a multiple of the daily return on the index, *not* a multiple of the buying and holding the index for a month or a year (see Avellaneda and Jian (2009)) so therefore we focus on daily ETF returns.

Finally, we consider both ETF returns after fees and before fees. Of course, the return the buyer of an ETF receives is net of fees, but we want to examine the extent to which our results are driven by fee differences between leveraged and unleveraged ETFs. As shown in Table I, twice-leveraged ETFs have expense ratios that are more than twice the expense ratio of unleveraged ETFs. The leveraged ETFs have fees ranging from 4 to 10 times the fees of the corresponding unlevered counterpart. We compute returns before fees by adding back the expense ratio to the daily return of the fund.

1.3. Option Portfolios by Maturity and Moneyness: Preliminary Evidence

We start by giving some summary statistics on portfolios of options. To show how options' embedded leverage varies as a function of moneyness and maturity, on each rebalance date, we assign each option to one of 30 groups based on its moneyness measured by delta and its time to expiration. We consider 5 groups of option deltas: deep out the money (DOTM), out of the money (OTM), at the money (ATM), in the money (ITM), and deep in the money (DITM). Similarly, we consider 6 groups based on the option expiration date from short-dated to long-dated. Options portfolios are rebalanced every month and weighted by their total market capitalization, defined as price times open interest. This is done separately for calls and puts and then we calculate the equal-weighted average of the two. We will use these 30 value-weighted portfolios extensively in our test. The Appendix reports the results separately for calls and puts.

Table III shows the precise ranges for deltas and times to expiration. More interestingly, Table III Panel A shows the embedded leverage in each group of equity options and Panel D shows the same for index options. We see that options in general have a large degree of embedded leverage, especially index options. Further, embedded leverage various systematically and significantly with moneyness and maturity. Short-dated DOTM equity options have embedded leverage above 16 while long-dated DITM equity options have embedded leverage close to 2. For index options, short-dated DOTM options have embedded leverage above 305 while long-dated DITM options have embedded leverage close to 3.

To put these numbers in perspective, recall that an embedded leverage of 35 means that an investors buying $1 worth of short-dated DOTM options gets a similar market exposure as buying $35 worth of the underlying index. This is clearly an enormous multiplication of returns generated by such options.

Panel B shows the average delta-hedged excess returns for each group of equity options, Panel E shows this for index options, and Panels C and F provide the corresponding t-statistics. We see that option returns tend to be negative, large in magnitude, and statistically significant, especially for options with large embedded leverage, which is consistent with our hypothesis. For instance, a number of option groups with large embedded leverage have monthly returns below minus 10 percent per month. Sections 2-6 test our hypothesis more formally and consider a number of risk-adjustments and robustness checks.

1.4. Construction of BAB Portfolios

We construct of BAB portfolios in a similar way to Frazzini and Pedersen (2010). For each underlying security, we build a self-financing long/short portfolio, which is long a value-weighted basket of low-embedded-leverage securities scaled to have an exposure to the underlying security of one, and short a value-weighted basket of high-embedded-leverage securities scaled to have on exposure of one. Hence, these portfolios are market neutral since the long and short sides have the same market exposure. The portfolios are effectively bets against embedded leverage and therefore useful to test the return premium associated with embedded leverage.

Let us explain in detail how we construct BAB portfolios, starting with the option portfolios. On each rebalance date, we sort all options on a given security based on their embedded leverage. We then assign each option to either a high- or low-embedded-leverage portfolio based on the median value of embedded leverage. For each group, we compute the average monthly excess return weighted by the market capitalizations of the options' open interest. We denote the weighted average embedded leverage of the high (H) and low (L) embedded leverage portfolio for underlying i by $\Omega^{H,i}$ and $\Omega^{L,i}$, respectively. Similarly, the corresponding excess returns are denoted by $r_t^{H,i}$ and $r_t^{L,i}$. With this notation, the excess returns of the BAB factor for underlying security *i* can be written as

$$BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i} \tag{5}$$

This gives the excess return on a zero-beta self-financing portfolio that is long low-embedded-leverage options and short high-embedded-leverage options. Dividing both the long and short sides by their average embedded leverage ($\Omega^{H,i}$ and $\Omega^{L,i}$) means that each has a unit exposure to the underlying, i.e., by construction this portfolio has a zero ex-ante exposure to the underlying spot price as measured by option delta. As noted in the introduction, this keeps a relatively balanced risk profile since position sizes $1/\Omega$ are scaled down (up) at times where options are more likely to experience larger (smaller) subsequent price movements.

We aggregate the BAB portfolios for all underlying securities of an asset class to an overall BAB portfolio for, respectively, equity options and index options. The overall BAB portfolio is simply a value-weighted portfolio of the individual BABs:

$$BAB_t = \sum_i \; w_{t-1}^i \, BAB_t^i \tag{6}$$

where the value weights $w_{t-1}^i = \; me_{t-1}^i / \sum_j me_{t-1}^j$ are based on the total market value of all outstanding options for security i, $me_{i,t-1}$. We construct BAB portfolios separately for puts and calls and report results for both. We also report results for an equally weighted portfolio of puts and calls

$$BAB_t^{All} = (BAB_t^{Call} + BAB_t^{Put})/2 \tag{7}$$

The ETF BAB portfolio is constructed in a similar fashion. It is simply a special case of (5) where the low leverage portfolio has a fixed leverage of 1 and the high leverage portfolio has a fixed leverage of 2. If we let $r_t^{1x,i}$ denote the excess return of the unlevered ETF on index *i* and $r_t^{2x,i}$ the excess return of the leveraged ETF, then the BAB portfolio for these ETFs is simply given by

$$BAB_t^{ETF,i} = \; r_t^{1x,i} - (1/2) \; * r_t^{2x,i} \tag{8}$$

Finally, the overall ETF BAB portfolio is the equal-weighted average of these individual ETF BABs.

1.5. Risk Adjustment

We obtain U.S. Treasury Bills rates, the three Fama and French (1993) factors, and the Carhart (1997) momentum factor from Kenneth French's data library.[5] Since our monthly option returns are computed from one roll date to the next, we need to compute monthly returns of the Fama and French (1993) and Carhart (1997) factors over the same window (rather than the standard monthly factor ends based on month-ends). To do this, we use daily returns on the self-financing long short portfolios, we add back cash rate, compound over the relevant horizon and compute excess returns. For example, the *HML* return between date 0 and T is given by

$$HML_{[0,T]} = \prod_{t=1}^{T}(1 + HML_t^d + r_t^f) - \prod_{t=1}^{T}(1 + r_t^f) \tag{5}$$

where HML_t^d is the daily *HML* return from French's data library. The other monthly risk factors at option expiration dates are computed in a similar way.

Following Coval and Shumway (2001) and Goyal and Saretto (2009), we also compute an additional aggregate volatility factor (straddle). The straddle factor is a portfolio that holds 1-month zero-beta at-the-money (ATM) S&P 500 index straddles, computed as follows: On each roll date, out of all options satisfying our portfolio inclusion requirements, we select all S&P 500 put-call pairs expiring on the following month with absolute value of delta between 0.4 and 0.6 and compute their value-weighted delta-hedged excess returns. Straddles are weighted by their total market capitalization, price times open interest.

2. Asset Classes with Embedded Leverage have Low Alphas

We first examine the overall return of asset classes with embedded leverage. In particular, we are interested in whether equity options, index options, and ETFs offer low returns relative to standard risk factors (constructed in Section 1.5). This question is addressed in Table IV. Panel A reports equally-weighted results, while Panel B has value-weighted ones.

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[5] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

The top of each panel considers equity options. We first form a monthly time series of delta-hedged excess returns for calls options (the columns labeled "Calls" in the table). This is done by taking the average of the 30 portfolios sorted by moneyness and maturity discussed in Table III, which ensures a relatively constant exposure to the various types of options. In Panel A, these 30 portfolios are "equally weighted" (though, recall that the options are value-weighted within each of the 30 portfolios), while in Panel B the 30 portfolios are "value weighted." We similarly construct a time series of hedged excess returns for put options ("Puts"), and, finally, we average the time series of call and put returns giving rise to the columns labeled "All" in the table. Similarly for index options, we compute hedged returns of "All", "Calls", and "Puts."

We also compute the excess returns of a sample of ETFs, equal weighted in Panel A and weighted by the market capitalization of the underlying indices in Panel B. For ETFs, we use daily data so that compounding effects do not influence our results.

Based on these portfolios, we estimate the average excess return, the 1-factor CAPM alpha, the 3-factor alpha that controls for the value and size effects, and the 4-factor alpha that additionally controls for momentum. The table reports both the alphas and their t-statistics. (We note that this table does not control for the Straddle factors used in the 5-factor models below. This is because the Straddle factor is constructed to capture the general tendency for options to have low returns, which is precisely the effect that this table seeks to establish in our dataset. We include the Straddle factor in our later cross-sectional tests in order to demonstrate that the outperformance of low-embedded-leverage options relative to high-embedded-leverage options is a separate statistical phenomenon, even if it is driven by the same economics.)

We see that all the equal weighted option portfolios in Panel A have large negative and statistically significant alphas, ranging from -4.9% to -1.7% per month. This is true both for calls, puts, and all, both for equity options and index options, and for all types of risk adjustment.

The value-weighted evidence in Panel B also shows that option portfolios have large negative alphas ranging from -3.3% to -0.7% per month, but the statistical significance tends to be weaker, and in some cases we are unable to reject the null of zero. The value-weighted results are weaker because it places less weight on the options with the least amount of embedded leverage.

For ETFs, we see that the point estimate of the alpha tends to be negative both in the equal- and value-weighted Panels, and for most of the risk adjustments, but these alphas are not statistically significant. The lack of statistical significance is perhaps not surprising given the short ETF sample period of less than 4 years.

Overall, results in table III and IV are consistent with the hypothesis that leverage-constraints investors are willing to pay a premium for securities with embedded leverage and intermediaries who meet this demand need to be compensated for their risk. As a result, aggregate portfolios of securities with embedded leverage earn lower average returns. While these results for the overall asset classes are consistent with our hypothesis, we can achieve much more statistical power in the cross-sectional tests that we consider next in Sections 3-5.

3. Embedded Leverage in the Cross Section: Portfolio Analysis

To test whether securities with more embedded leverage offer lower returns, we proceed in three ways: We consider portfolios sorted on embedded leverage, long/short BAB factors that bet against embedded leverage, and regression analysis (Section 4).

We first sort double sort options into portfolios based on maturity and moneyness as discussed in Section 1.3 and Table III. The connection between the embedded leverage of the hedged excess returns on these option portfolios is illustrated in Figure 1, showing embedded leverage on the x-axes and average returns on the y-axes, as well as a fitted cross sectional regression. We see a clear negative relationship both for equity options and for index options: portfolios with higher embedded leverage have lower average returns. Figures A1 and A2 in the appendix report the results separately for puts and calls.

Table V tests whether this negative relationship between return and embedded leverage also holds when we adjust for the risk exposures to various standard risk models. For ease of exposition, we aggregate portfolios in two ways, namely into portfolios sorted on maturity and moneyness, respectively. To compute the return of portfolios sorted by maturity, we take the equal-weighted average across moneyness of the double-sorted portfolios in Table III. Similarly, to compute moneyness portfolios, we take the average across maturities in each group. Table V analyzes these portfolios both for equity options (Panel A) and for index options (Panel B).

Both for equity options and index options, we see that shorter maturity options have larger embedded leverage. Further, consistent with our hypothesis, we see that the high-embedded-leverage options have negative and significant alphas and that alphas are almost monotonic in embedded leverage. This holds both for 4-factor alphas that control for the market, value, size, and momentum, and for 5-factor alphas that additionally control for the straddle factor that captures the general premium of options. Also, a long-short strategy that goes long the portfolio with low embedded leverage and shorts the portfolio with high embedded leverage earns significant alpha between 7.5% and 11.5% per month with t-statistics ranging between 6.7 and 12.0.

Similar results hold when we sort based on moneyness. We first see that naturally out-of-the-money options have larger embedded leverage than in-the-money options. Further, the alphas of the OTM options are negative and significant, and alphas are close to monotonic, and the long-short portfolio has significant alphas between 5.2% and 7.4% per month based on the 4-factor model (t-statistics of 3.79 and 3.84). While the alphas based on the 5-factor model show the same patterns, they are not statistically significant.

One issue with the long/short strategies in Table V is that the portfolios on the short side with high embedded leverage have much larger volatilities than the portfolios on the long side with low embedded leverage. Hence, the return on such a strategy mostly reflects the return of the short side, while the return of the long portfolio is swamped. This disparity in risk is due to the standard convention of having the same notional exposure on the long and short sides, namely the convention of going long $1 and short $1.

Instead, we can consider a strategy that has the same risk exposure (rather than notional exposure) on the long and short side. This is exactly what a betting-against-beta BAB factor does (following Frazzini and Pedersen (2010), as explained in detail in Section 1.4). Recall that a BAB is constructed as

$$BAB_t^i = \left(1/\Omega_{t-1}^{L,i}\right) r_t^{L,i} - \left(1/\Omega_{t-1}^{H,i}\right) r_t^{H,i}$$

We see that the long-side of the portfolio is scaled to have an exposure of 1 since we divide by the embedded leverage Ω^L of the low-embedded-leverage securities. Similarly, the short side of the portfolio is scaled to have an exposure of 1. Thus the long and short side of the portfolio have equal exposure, making the portfolio market neutral and balances the importance of the long and short sides. Therefore, the BAB return does not reflect moves in the underlying, but rather the discrepancy between getting market exposure using high-embedded-leverage securities relative to that of low-embedded-leverage securities. The BAB portfolios represent our main test assets.

Figure 2 shows the Sharpe ratios of all the 14 BAB factors that we consider. First, we consider 6 BAB factors of equity options, both for all options, call options, put options, all ATM options, ATM call options, and ATM put options. Second, we consider 6 BAB factors of index options, categorized in the same way. Third, we consider a BAB factor of all leveraged ETFs' net returns, and a BAB factor of all leveraged ETF returns with fees/expenses added back. We see that all BAB factors have large Sharpe ratios, often in excess of 1 and with some as high as 2. This strong performance suggests that investors put a high premium on embedded leverage.

Table VI presents in more detail our evidence on the performance of these BAB factors for equity options, index options, and ETFs, including the Sharpe ratios of Figure 2 in the last row. For each of these BAB factors, Table VI shows large and significant average returns and 5-factor alphas. Each of these overall BAB factors is a weighted average of BAB factors based on, respectively, all the options on each underlying equity, all options on each underlying stock index, and all pairs of leveraged/unleveraged ETFs. Alphas for option BABs range between 14 and 44 basis point per month with t-statistics between 2.7 and 8.0. ETFs alphas are between 7 and 9 basis points per month with t-statistics between 2.5 and 3.4. Table VII also reports the fraction of the individual BAB factors that have positive alphas (labeled "Frac(Alpha>0)"), and we see that most of the individual BAB factors have positive abnormal returns, with index options being the extreme case where all the individual indices have BAB returns with positive alphas. Figures A3 and A4 in the appendix plot the time series of returns.

Table VI also shows the risk exposures of the BAB factors. The realized market exposures (which should be zero ex ante) are close to zero but there are some positive and negative ones. Of course, even if the realized market exposure is different from zero, this is captured in the alphas. The BAB factors have little exposure to the size factor SMB, and only occasionally a small and negative exposure to the HML, UMD, and Straddle returns.

The table also shows the average embedded leverage of the long and short sides of the BAB factors. By construction, the embedded leverage is larger on the short side of the portfolio. As a result, the notional exposures of the short positions (labeled "Dollar short") are larger than the notional exposures of the long positions (labeled "Dollar long"). Both the long and short sides have notional exposures less than 1 since they have been scaled to unit exposure and all options have some degree of embedded leverage. Said differently, the average notional exposures are naturally (close to) the inverse of the average embedded leverage.

To summarize, the evidence in Table VI is consistent with the hypothesis of the existence of a premium for securities that embed leverage and therefore alleviate investors' constrains by increasing their return per unit of committed capital. Indeed, portfolios that are long a basket of low-embedded-leverage securities and short a basket of high-embedded-securities earn high subsequent returns.

4. Embedded Leverage in the Cross Section: Regression Analysis

To show that our result that high embedded leverage is associated with lower subsequent returns is not an artifact of our BAB portfolio construction, Table VII instead tests the pricing of embedded leverage using a cross-sectional regression. This table reports coefficients from Fama-MacBeth regressions in which the dependent variable is the delta-hedged option excess return in month *t* (or, the excess return of ETFs on day *t*, since the ETF regressions are run daily). The explanatory variables are the security's embedded leverage Ω_{t-1} as well as a number of control variables. For options, the control variables are the "*Total open interest*" (the dollar open interest of all outstanding options for a given security), *"Maturity "* (the option's maturity in months), "*Moneyness*" (the ratio of $(\mathrm{S}-\mathrm{X})\ /\ \mathrm{S}$ for call options and $(\mathrm{X}-\mathrm{S})/S$ for put options where *X* is the strike price), "*1-Month spot volatility*" (the standard deviation of the daily spot returns over the past month), "*Implied volatility"*, *"Vega"* and *"Gamma"*, "*12-Month spot volatility*", "*Stock return*" the month t stocks of index excess return, "*Option turnover*" (defined as log(1 + *volume/open interest*)), and "*Total option turnover*" (defined as log(1+*total volume / total open interest*) where *total volume* is the sum of dollar volume of all outstanding options for a given underlying security).

Since we are running cross-sectional regressions of excess returns on lagged embedded leverage, the time series of cross sectional coefficients can be interpreted as the monthly returns of a self-financing portfolio that hedge out the risk exposure of the remaining variables on the right-hand side (see Fama (1976)). We report the average slopes estimates (corresponding to average excess returns) and, when indicated by the "Risk Adjusted" flag, abnormal returns. Abnormal returns (alphas) are the intercept of a second-stage regression of monthly excess returns (i.e., slope estimates from the first-stage regression) on the 5-factors used in Table VI. The standard errors are adjusted to heteroskedasticity and autocorrelation up to 12 months.

In each of the regression specifications, we see that high embedded leverage predicts lower subsequent returns. The coefficients are large (pooling all columns in table VI, on average around -125 basis point per month) and highly statistically significant in all of the specifications using equity options and index options. The coefficient is also negative and marginally significant for the ETF sample. To summarize, regression results in table VII are consistent with our evidence on portfolio sorted by maturity and moneyness in table V as well as our results for BAB portfolio in table VI: derivative securities that embed leverage to a larger degree earn substantially lower subsequent returns.

5. Robustness Analysis and Alternative Hypotheses

While the large alphas of the BAB factors and the significant results of the cross sectional regressions are consistent with our hypothesis that investors prefer embedded leverage, we must also consider alternative hypotheses. One alternative hypothesis is that these alphas reflect tail risk, while another alternative hypothesis is that they reflect poor statistical properties due to highly non-Normal returns. To evaluate these alternative hypotheses, Figure 3 plots the empirical distribution of the main BAB factors. We see that while the BAB returns are not exactly Normally distributed (a Jarque–Bera test strongly reject the null of normality), the distribution is far closer to a bell curve than many of the option strategies considered in the literature (e.g., see Broadie, Johannes, and Chernov

(2009)). While most of the literature focuses exclusively on S&P500 options, our BAB factors have several features that improve their statistical properties: (i) we diversify and value-weight across, respectively, 12 indices and almost 3000 equities; (ii) we delta hedge the strategy daily; and (iii) we are both long and short options; and (iv) our BAB factors keep constant notional exposure rather than a constant dollar exposure, thus automatically dampening occurrences of extreme return realizations.

To put in perspective the non-Normality of the BAB factor returns, Table VIII reports summary statistics, skewness and excess kurtosis of the BAB factors as well as standard factor returns over respectively, a longer sample period and an overlapping sample period. The BAB factors have skewness between -0.87 and 0.41 and excess kurtosis of between 1.16 and 4.57 compared. These values are comparable to those of the standard factors in the overlapping sample, while the standard factors in the long sample are more non-Normal with excess kurtosis of 22.21, 15.54 and 26.67 for SMB, HML and UMD. Hence, although we can safely reject normality in all factors (including the standard ones), we see that the BAB factors are, if anything, less extreme than the full history of the standard risk factors, which does not support the alternative hypothesis regarding the statistical properties.

Also, the evidence does not point toward compensation for tail risk. We compute the return of the BAB factors during recession and expansions, during severe bear markets (defined as total market returns in the past 12-month below -25%) and during periods of market stress (defines as a contemporaneous market return below -5% and -10%). We find no evidence of compensation for tail risk. We report these results in Table IX.

The Appendix contains a battery of additional robustness checks. We report returns and alphas of our equity, index and (when available) ETFs BAB portfolios. Table A4 reports results for alternative risk adjustments. In Table A5, we split the sample by time periods and report results for the various sub-samples. In Table A6, we report results for options BAB constructed within each moneyness and maturity groups. Finally, Table A7 uses only equity call options of non-dividend payers to ensure that our results are not driven by early exercise of American options. (Recall that we also have a portfolio screen to account for this.) We do this in two ways. First we restrict the sample to options that never paid a dividend over the full sample. Obviously this method suffers from look-ahead bias. Second, we restrict the sample to firms that have never paid a dividend as of portfolio formation date. In table A8 we report returns using different assumption for borrowing rates, sorting rates based on their average spread over the Treasury bill. We use overnight repo rate, the overnight indexed swap rate, the effective federal funds rate, and the 1-month and -3 month LIBOR rate. The robustness checks in the Appendix are consistent with our main finding that high embedded leverage predicts lower subsequent returns, providing an extensive overall amount of evidence.

6. Conclusion

We propose that a security's embedded leverage is an important economic characteristic. We test the hypothesis that securities with large embedded leverage help alleviate investors' leverage constraints and, therefore, have a lower required return, finding strong evidence for the pricing of embedded leverage for equity options, index options, and leveraged ETFs.

Embedded leverage may have broader effects on the financial markets than the asset classes that we study. For instance, equity in firms with debt are securities with embedded leverage on the firm value. Hence, future research may show how the pricing of embedded leverage affects corporate finance decisions. One could imagine a trade-off model in which firms trade off the costs of financial distress against the benefits of providing embedded leverage.

Also, the whole securitization market may be affected by embedded leverage considerations. For instance, the risky trances of a securitized product embed leverage on the underlying economic risks, e.g., mortgage risk. In a market in which certain investors prefer AAA-rated securities while other investors seek embedded leverage, tranching may be the security design that meets both these demands. Certainly, embedded leverage was a crucial consideration in the security design of leveraged ETFs and options so it is possible that it affects other security designs and economic decisions.

The private equity industry also offers embedded leverage as the portfolio companies are typically leveraged, e.g. through leveraged buyouts (LBOs). Similarly, the hedge fund industry offers embedded leverage on a variety of strategies that would have low risk and expected return on an unleveraged basis.

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Appendix A: Embedded Leverage and Margin Requirements

While our focus is on securities that directly embed leverage, one can also consider the return magnification when the position is bought on margin with a margin requirement. The embedded leverage of a position in a security with market value *F* leveraged with a margin requirement of *m* is given by:

$$\Omega = \left|\frac{\partial F}{\partial S} S/m\right| \tag{A.1}$$

In general, the denominator *m* in the calculation of embedded leverage should be the *minimal amount of capital* an investor needs to commit to the trade. To see this, consider the following examples:

First, if an option is further leveraged through a margin loan as in (A.1), then the overall embedded leverage in the position is even higher than the embedded leverage that we use in our analysis (based on Equation (1)). We focus on the embedded leverage of derivatives bought for cash (i.e., not margined) since many investors simply rely on the option's own embedded leverage without the ability or willingness to add outright leverage through margining. Indeed, as mentioned in the introduction, many investors buy securities with embedded leverage specifically to avoid outright leverage. Avoiding outright leverage limits the potential loss to minus 100%, eliminates the need for dynamic rebalancing, and circumvents potential rules against leverage, among other advantages.

Second, some derivatives such as futures contracts are constructed to have an initial market value of zero. Such derivatives would in principle have in an infinite embedded leverage as per Equation (1). However, to enter into such a security position one must post a margin requirement. Since investors naturally cannot achieve an infinite market exposure, Equation (A.1) is a more meaningful definition of embedded leverage for such securities. Said differently, for futures one must compute the embedded leverage of the portfolio of the futures contract *plus* the margin collateral. Applying the initial definition from (1) to compute the embedded leverage of this portfolio yields precisely (A.1). This is because the return sensitivity remains $\partial F/\partial S$ and the market value of the portfolio is *m*.

Third, short positions also associated with margin requirements (so shorting does not free up capital). For options, margin requirements are not the same for long and short positions. Santa-Clara and Saretto (2009) report that on average, “a customer must deposit $6.60 as margin (in addition to the option sale proceeds) for every dollar received from writing ATM puts.” For a put option that is 10% out of the money, the margin requirement is much higher yet, 29.6 times the value of the option on average and as high as 116.7 times in the sample of Santa-Clara and Saretto (2009). Hence, the return magnification from writing put options is significantly diminished considering the large margin requirements. For this and other reasons, investors often prefer to obtain embedded leverage through buying options.

Appendix B: Embedded Leverage on the Short Side: Put Options

In the model of Frazzini and Pedersen (2010), agents have no hedging demands and no differences of opinions. Hence, there is no demand for embedded leverage on the short side of the market. Here we briefly sketch how such a demand for embedded leverage for shortselling can arise and be priced. The intuition is with heterogeneous agents with different endowment risk (or differences of options), some agents may want to sell short. If such agents are capital constrained then they prefer securities the embed leverage on short exposure.

We consider an economy with two types of agents, a and b, that differ in their labor income e^i. The economy has a risk free asset with return r^f , a "market" asset with final payoff P^0_{t+1} and x* shares outstanding, and some "put options" with final payoffs P^s_{t+1}, s=1,…,S, and zero shares outstanding. Agent i maximizes the following objective function:

$$\max x'\left(E_t\left(P_{t+1}\right) - (1+r^f)P_t\ \right) - \frac{\gamma^i}{2}\mathrm{var}(x'P_{t+1} + e^i)$$

subject to the constraint[1] that $x \geq 0$ and the capital constraint

$$\sum_s x^s P^s_t \leq W^i_t$$

where $\underline{P_t}$ is the vector of prices, γ^i is agent i's risk aversion, and W^i is the wealth. Suppose that agent a's labor income has much more market risk than that of agent b (i.e., $\mathrm{cov}(P^0_{t+1}, e^a)$ is much larger than $\mathrm{cov}(P^0_{t+1}, e^b)$) such that, in equilibrium, agent b holds all the shares outstanding of the market asset while agent a has a larger demand for the put options. Therefore, agent a's first order condition prices the put options:

[1] Many investors are prohibited from writing options. E.g., brokers do not allow investors to write options unless they can document a sufficient level of sophistication and some institutional investors have rules against writing options. Further, the high margin requirements on writing options makes them less attractive from the standpoint of a capital constrained investor as discussed in the end of Appendix A.

$$0= E_t\left(P_{t+1}\right) - (1+r^f)P_t \ \ - \gamma^a(Vx+V_{ex}) - \psi P_t \ \ + q$$

where V=$\text{var}(P_{t+1})$, element s in V_{ex} is $\text{cov}(P^s_{t+1}, e^a)$, ψ is the Lagrange multiplier for the capital constraint, and q has the Lagrange multipliers for the shortsale constraints. Given that this first-order condition must be satisfied at x=0, we have the following equation for the expected returns of the put options (where the return r is naturally defined as $r^s_{t+1} = \frac{P^s_{t+1}}{P^s_t} - 1$ and the shortsale constraints do not bind for agent a because of his large hedging demand):

$$E_t(r^s_{t+1}) = r^f + \psi + \gamma^a \, \text{cov}(r^s_{t+1}, e^a)$$

Finally, consider a BAB portfolio that goes long put options with low embedded leverage Ω^L and short put options with a high embedded leverage Ω^H, i.e., $\Omega^H > \Omega^L$. The expected excess return on this portfolio is:

$$E_t(r^{BAB}_{t+1}) = \frac{r^L_{t+1} - r^f}{\Omega^L} - \frac{r^H_{t+1} - r^f}{\Omega^H} = \frac{\Omega^H - \Omega^L}{\Omega^H \ \Omega^L}\psi \geq 0$$

where assume that $\text{cov}(r^L_{t+1}, e^a)\,/\Omega^L = \text{cov}(r^H_{t+1}, e^a)\,/\Omega^H$ since the options are derivatives on the same underlying that just have different amounts of embedded leverage. Importantly, the embedded leverage Ω^s is defined with an absolute value as in Equation (1). With this notation, the BAB portfolio has a positive expected return when it goes long low-omega securities and shorts high-omega ones.

In summary, the put options have low expected return because of their hedging benefits to the marginal investor, $\text{cov}(r^s_{t+1}, e^a) < 0$, but the expected returns are elevated if the investor's capital constraint is binding such that $\psi > 0$. For put options with high embedded leverage, then return elevation due to ψ is low in a risk-adjusted sense (i.e., ψ / Ω^H is low). Intuitively, the investor is willing to accept a particularly low risk-adjusted return for put options with high embedded leverage as such options provide hedging benefits per unit of capital that they tie up.

Appendix C: Additional Empirical Results and Robustness Tests

Tables A1 to A8 and Figures A1 to A4 contain additional empirical results and robustness tests.

— Table A1 reports implied volatilities, Sharpe ratios, Gammas and Vegas of 30 option portfolios sorted by maturity and moneyness.

— Table A2 and A3 report embedded leverage, excess returns and summary statistics of 30 option portfolios sorted by maturity and moneyness. We report results for calls and puts separately.

— Table A4 reports alphas of our equity, index and ETF BAB portfolios for alternative risk adjustments.

— Table A5 reports alphas of our equity, index and ETF BAB portfolios. We split the sample by time periods and report returns for the various sub-samples.

— Table A6 reports results for options BAB constructed within each moneyness and maturity groups.

— Table A7 report s results for options BAB using only equity call options of non-dividend payers. We do this in two ways. First we restrict the sample to options that never paid a dividend over the full sample. Second, we restrict the sample to firms that have never paid a dividend as of portfolio formation date.

— Table A8 reports alphas of our equity, index and ETF BAB portfolios. We report returns using different assumption for borrowing rates, sorting rates based on their average spread over the Treasury bill. We use overnight repo rate, the overnight indexed swap rate, the effective federal funds rate, and the 1-month and -3 month LIBOR rate. If the interest rate is not available over a date range, we use the 1-month Treasury bills plus the average spread over the entire sample period.

— Figure A1 and A2 plot results from cross sectional regressions of excess returns on embedded leverage corresponding to table A2 and A3.

— Figure A3 and A4 plot the time series of returns of our equity, index and ETF BAB portfolios.

Table A1
Implied Volatility, Sharpe Ratio, Gamma and Vega across Maturity and Moneyness

This table shows calendar-time portfolio returns and summary statistics of option portfolios based on maturity and moneyness. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option's delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolios based on the option's expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio and average them. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010.

Equity Options		Abs(delta) range		Maturity (months)					
				1	2	3	6	12	>12
Panel A	Deep out of the money	0.00	0.20	0.52	0.42	0.44	0.38	0.31	0.36
Implied volatility	Out of the money	0.20	0.40	0.47	0.38	0.42	0.37	0.29	0.33
	At the money	0.40	0.60	0.43	0.37	0.41	0.38	0.30	0.33
	In the money	0.60	0.80	0.43	0.42	0.45	0.40	0.33	0.34
	Deep in the money	0.80	1.00	0.46	0.43	0.42	0.37	0.31	0.34
Panel B	Deep out of the money	0.00	0.20	-2.14	-0.99	-0.65	-0.35	-0.09	0.15
Sharpe ratio	Out of the money	0.20	0.40	-2.56	-1.29	-0.82	-0.33	-0.08	0.00
	At the money	0.40	0.60	-2.22	-1.31	-0.56	-0.22	-0.05	-0.03
	In the money	0.60	0.80	-2.18	-0.99	-0.67	-0.06	0.05	0.17
	Deep in the money	0.80	1.00	-1.50	-0.24	-0.50	0.40	0.29	0.51
Panel C	Deep out of the money	0.00	0.20	3.05	2.07	2.09	1.37	0.82	0.94
Gamma *100	Out of the money	0.20	0.40	5.02	3.26	3.51	2.50	1.36	1.57
	At the money	0.40	0.60	5.43	3.78	4.10	3.10	1.73	1.93
	In the money	0.60	0.80	4.86	4.20	4.21	3.14	2.09	2.12
	Deep in the money	0.80	1.00	3.98	3.49	3.32	2.66	2.07	1.51
Panel D	Deep out of the money	0.00	0.20	16.0	38.8	33.4	68.5	121.3	102.7
Vega	Out of the money	0.20	0.40	34.3	72.3	57.1	102.4	200.5	164.3
	At the money	0.40	0.60	48.7	83.5	66.6	103.8	210.3	165.4
	In the money	0.60	0.80	41.1	52.9	41.4	77.8	146.2	103.2
	Deep in the money	0.80	1.00	19.9	21.2	19.4	34.6	63.4	34.7

Table A1 (continued)
Implied Volatility, Sharpe Ratio, Gamma and Vega across Maturity and Moneyness

This table shows calendar-time portfolio returns and summary statistics of option portfolios based on maturity and moneyness. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option's delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolios based on the option's expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio and average them. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010.

Index Options		Abs(delta) range		Maturity (months)					
				1	2	3	6	12	>12
Panel A	Deep out of the money	0.00	0.20	0.25	0.24	0.23	0.23	0.23	0.23
Implied volatility	Out of the money	0.20	0.40	0.22	0.22	0.22	0.22	0.21	0.21
	At the money	0.40	0.60	0.22	0.22	0.21	0.22	0.21	0.21
	In the money	0.60	0.80	0.22	0.22	0.22	0.22	0.22	0.22
	Deep in the money	0.80	1.00	0.27	0.26	0.25	0.26	0.25	0.24
Panel B	Deep out of the money	0.00	0.20	-1.73	-1.09	-0.86	-0.37	-0.13	-0.04
Sharpe ratio	Out of the money	0.20	0.40	-1.56	-1.29	-0.95	-0.43	-0.06	0.02
	At the money	0.40	0.60	-1.31	-1.38	-0.88	-0.53	-0.08	0.05
	In the money	0.60	0.80	-1.24	-1.19	-0.71	-0.47	-0.24	0.05
	Deep in the money	0.80	1.00	-1.30	-0.86	-0.38	-0.18	0.01	-0.12
Panel C	Deep out of the money	0.00	0.20	0.43	0.31	0.32	0.21	0.21	0.18
Gamma *100	Out of the money	0.20	0.40	0.80	0.57	0.52	0.35	0.27	0.24
	At the money	0.40	0.60	0.95	0.67	0.60	0.41	0.32	0.24
	In the money	0.60	0.80	0.86	0.63	0.58	0.40	0.40	0.28
	Deep in the money	0.80	1.00	0.52	0.42	0.39	0.27	0.24	0.19
Panel D	Deep out of the money	0.00	0.20	61.6	89.1	86.4	142.0	187.0	255.0
Vega	Out of the money	0.20	0.40	111.2	152.7	146.8	243.6	320.1	430.3
	At the money	0.40	0.60	125.2	171.9	166.7	269.5	354.5	482.8
	In the money	0.60	0.80	107.5	145.8	142.0	229.3	290.0	377.2
	Deep in the money	0.80	1.00	52.1	71.5	74.2	115.0	158.9	213.5

Table A2
Embedded Leverage and Excess Returns across Maturity and Moneyness, Call Options

This table shows calendar-time portfolio returns and summary statistics of option portfolios based on maturity and moneyness. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option's delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolios based on the option's expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio and average them. This table includes all available call options on the domestic OptionMetrics Ivy database between 1996 and 2010. "Embedded leverage" is defined as $\Omega = |\Delta S/F|$ where Δ is the option delta, F is the option price and S is the spot price. Returns are monthly in percent, and 5% statistical significance is indicated in bold.

Equity Call Options		Abs(delta) range		Maturity (months)						
				1	2	3	6	12	>12	Sum
Panel A	Deep out of the money	0.00	0.20	0.21	0.22	0.21	0.53	0.53	0.50	2.19
Percent of total	Out of the money	0.20	0.40	0.96	0.92	0.86	2.26	2.31	2.19	9.49
open interest	At the money	0.40	0.60	2.39	2.15	2.12	4.95	5.35	6.30	23.26
	In the money	0.60	0.80	4.21	3.40	3.00	7.46	8.08	10.47	36.62
	Deep in the money	0.80	1.00	3.66	2.97	2.73	6.28	6.75	6.05	28.44
	Sum			11.42	9.66	8.93	21.46	23.02	25.51	100.00
Panel B	Deep out of the money	0.00	0.20	1.36	0.77	0.36	0.61	0.33	0.18	3.62
Percent of total	Out of the money	0.20	0.40	4.96	3.56	1.87	3.39	1.91	1.18	16.87
volume	At the money	0.40	0.60	9.02	6.44	4.06	6.67	4.68	3.82	34.68
	In the money	0.60	0.80	10.11	4.96	2.67	4.97	3.27	4.18	30.15
	Deep in the money	0.80	1.00	5.94	2.25	1.25	2.17	1.44	1.62	14.67
	Sum			31.39	17.98	10.21	17.81	11.62	10.99	100.00

Index Call Options		Abs(delta) range		Maturity (months)						
				1	2	3	6	12	>12	Sum
Panel C	Deep out of the money	0.00	0.20	0.42	0.29	0.17	0.47	0.56	0.71	2.62
Percent of total	Out of the money	0.20	0.40	1.22	0.98	0.63	1.67	2.42	2.17	9.09
open interest	At the money	0.40	0.60	2.71	2.55	2.05	3.73	5.71	6.83	23.58
	In the money	0.60	0.80	4.73	3.93	2.58	6.23	8.11	9.19	34.76
	Deep in the money	0.80	1.00	9.19	4.51	3.35	6.27	4.35	2.29	29.95
	Sum			18.26	12.26	8.78	18.37	21.14	21.19	100.00
Panel D	Deep out of the money	0.00	0.20	2.26	1.57	0.34	0.46	0.38	0.30	5.30
Percent of total	Out of the money	0.20	0.40	6.00	5.27	2.06	2.27	1.92	1.22	18.74
volume	At the money	0.40	0.60	9.07	9.84	5.71	5.05	5.27	4.28	39.22
	In the money	0.60	0.80	7.90	6.57	2.58	2.68	2.31	2.20	24.24
	Deep in the money	0.80	1.00	6.24	3.18	1.00	1.13	0.70	0.24	12.49
	Sum			31.48	26.43	11.69	11.58	10.58	8.23	100.00

Table A2 (continued)
Embedded Leverage and Excess Returns across Maturity and Moneyness, Call Options

This table shows calendar-time portfolio returns and summary statistics of option portfolios based on maturity and moneyness. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option's delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolios based on the option's expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio and average them. This table includes all available call options on the domestic OptionMetrics Ivy database between 1996 and 2010. "Embedded leverage" is defined as $\Omega = |\Delta S/F|$ where Δ is the option delta, F is the option price and S is the spot price. Returns are monthly in percent, and 5% statistical significance is indicated in bold.

Equity Call Options		Abs(delta) range		Maturity (months)					
				1	2	3	6	12	>12
Panel E	Deep out of the money	0.00	0.20	17.04	15.42	13.37	13.12	12.30	7.64
Embedded leverage	Out of the money	0.20	0.40	15.66	14.18	11.14	9.79	9.04	5.59
	At the money	0.40	0.60	14.79	12.23	8.94	7.58	6.84	4.39
	In the money	0.60	0.80	12.56	8.99	6.68	5.92	5.11	3.37
	Deep in the money	0.80	1.00	8.75	5.95	4.78	4.17	3.46	2.40
Panel F	Deep out of the money	0.00	0.20	**-30.29**	**-14.34**	**-8.41**	**-4.88**	-2.46	-0.64
Delta hedged excess returns	Out of the money	0.20	0.40	**-16.68**	**-8.10**	**-5.17**	-1.62	-0.62	-0.82
	At the money	0.40	0.60	**-9.18**	**-3.91**	**-2.06**	-0.21	0.05	-0.27
	In the money	0.60	0.80	**-3.89**	-0.96	**-1.32**	0.26	0.12	0.05
	Deep in the money	0.80	1.00	**-1.00**	0.21	-0.38	0.45	0.02	0.15
Panel F	Deep out of the money	0.00	0.20	-13.25	-5.73	-3.86	-2.20	-1.14	-0.37
t-statistics	Out of the money	0.20	0.40	-9.26	-5.03	-4.21	-1.38	-0.55	-0.89
Delta hedged excess returns	At the money	0.40	0.60	-7.55	-4.16	-2.58	-0.30	0.08	-0.52
	In the money	0.60	0.80	-5.21	-1.81	-2.92	0.64	0.32	0.19
	Deep in the money	0.80	1.00	-2.05	0.67	-1.52	1.80	0.10	0.81

Index Call Options		Abs(delta) range		Maturity (months)					
				1	2	3	6	12	>12
Panel G	Deep out of the money	0.00	0.20	44.28	31.82	26.84	20.67	15.48	11.29
Embedded leverage	Out of the money	0.20	0.40	33.16	23.12	18.98	14.82	11.18	8.02
	At the money	0.40	0.60	24.67	17.11	14.07	10.92	8.28	5.87
	In the money	0.60	0.80	17.99	12.58	10.22	7.87	6.03	4.42
	Deep in the money	0.80	1.00	10.28	7.43	6.17	4.94	3.94	3.19
Panel H	Deep out of the money	0.00	0.20	**-37.50**	**-18.51**	**-13.11**	-4.92	-2.15	-2.00
Delta hedged excess returns	Out of the money	0.20	0.40	**-14.83**	**-9.72**	**-6.44**	-2.15	0.05	-0.35
	At the money	0.40	0.60	**-7.31**	**-5.36**	**-3.68**	-1.51	-0.03	-0.15
	In the money	0.60	0.80	**-3.05**	**-2.41**	**-1.80**	-0.64	0.10	-0.15
	Deep in the money	0.80	1.00	-0.57	-0.18	-0.51	0.00	0.17	0.07
Panel I	Deep out of the money	0.00	0.20	-6.14	-3.65	-2.90	-1.34	-0.81	-0.84
t-statistics	Out of the money	0.20	0.40	-4.75	-4.33	-3.26	-1.28	0.04	-0.31
Delta hedged excess returns	At the money	0.40	0.60	-4.15	-4.27	-3.17	-1.73	-0.04	-0.25
	In the money	0.60	0.80	-2.80	-3.29	-2.57	-1.36	0.25	-0.45
	Deep in the money	0.80	1.00	-1.24	-0.58	-1.00	-0.01	1.06	0.40

Table A3

Embedded Leverage and Excess Returns across Maturity and Moneyness, Put Options

This table shows calendar-time portfolio returns and summary statistics of option portfolios based on maturity and moneyness. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option's delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolios based on the option's expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio and average them. This table includes all available put options on the domestic OptionMetrics Ivy database between 1996 and 2010. "Embedded leverage" is defined as $\Omega = |\Delta S/F|$ where Δ is the option delta, F is the option price and S is the spot price. Returns are monthly in percent, and 5% statistical significance is indicated in bold.

Equity Put Options		Abs(delta) range		Maturity (months)						
				1	2	3	6	12	>12	Sum
Panel E	Deep out of the money	0.00	0.20	0.74	1.01	0.90	2.27	2.66	3.20	10.77
Percent of total	Out of the money	0.20	0.40	2.00	2.23	2.10	5.62	6.28	7.99	26.22
open interest	At the money	0.40	0.60	3.13	3.03	2.79	6.49	7.20	7.74	30.38
	In the money	0.60	0.80	4.27	3.29	2.63	5.98	5.98	4.70	26.85
	Deep in the money	0.80	1.00	1.51	0.88	0.54	1.16	1.17	0.52	5.78
	Sum			11.63	10.45	8.97	21.51	23.29	24.16	100.00
Panel F	Deep out of the money	0.00	0.20	3.19	4.02	1.89	2.57	1.55	1.32	14.55
Percent of total	Out of the money	0.20	0.40	7.10	7.50	3.94	7.10	5.16	4.03	34.82
volume	At the money	0.40	0.60	8.31	7.17	4.17	6.24	4.38	2.72	32.98
	In the money	0.60	0.80	6.36	2.95	1.64	2.33	1.14	0.83	15.26
	Deep in the money	0.80	1.00	1.42	0.39	0.17	0.20	0.15	0.05	2.39
	Sum			26.39	22.02	11.81	18.44	12.38	8.96	100.00

Index Put Options		Abs(delta) range		Maturity (months)						
				1	2	3	6	12	>12	Sum
Panel G	Deep out of the money	0.00	0.20	1.05	0.88	0.65	1.58	2.00	2.70	8.86
Percent of total	Out of the money	0.20	0.40	1.95	1.85	1.42	3.49	4.57	6.11	19.39
open interest	At the money	0.40	0.60	2.35	2.37	1.84	3.56	4.95	5.76	20.83
	In the money	0.60	0.80	2.92	2.24	1.25	3.16	4.19	3.36	17.13
	Deep in the money	0.80	1.00	9.92	4.92	2.58	6.84	7.44	2.09	33.79
	Sum			18.19	12.27	7.74	18.64	23.15	20.02	100.00
Panel H	Deep out of the money	0.00	0.20	5.56	4.95	2.17	2.02	1.52	1.30	17.51
Percent of total	Out of the money	0.20	0.40	8.26	8.92	4.22	5.79	5.13	3.80	36.12
volume	At the money	0.40	0.60	7.18	8.27	4.64	4.68	4.15	2.56	31.48
	In the money	0.60	0.80	3.45	2.61	1.33	0.87	0.64	0.42	9.32
	Deep in the money	0.80	1.00	1.87	1.30	0.93	0.86	0.44	0.17	5.57
	Sum			26.32	26.05	13.28	14.22	11.88	8.25	100.00

Table A3 (continued)
Embedded Leverage and Excess Returns across Maturity and Moneyness, Put Options

This table shows calendar-time portfolio returns and summary statistics of option portfolios based on maturity and moneyness. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option's delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolios based on the option's expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio and average them. This table includes all available put options on the domestic OptionMetrics Ivy database between 1996 and 2010. "Embedded leverage" is defined as $\Omega = |\Delta S/F|$ where Δ is the option delta, F is the option price and S is the spot price. Returns are monthly in percent, and 5% statistical significance is indicated in bold.

Equity Put Options		Abs(delta) range		Maturity (months)					
				1	2	3	6	12	>12
Panel E	Deep out of the money	0.00	0.20	15.93	14.95	10.29	9.18	7.14	4.12
Embedded leverage	Out of the money	0.20	0.40	14.31	13.23	8.89	7.71	6.29	3.70
	At the money	0.40	0.60	13.14	10.85	7.38	6.10	5.24	3.00
	In the money	0.60	0.80	10.33	7.08	5.00	4.33	3.74	2.33
	Deep in the money	0.80	1.00	7.21	5.26	4.28	3.98	3.63	2.53
Panel F	Deep out of the money	0.00	0.20	**-19.13**	**-8.52**	-4.12	-1.04	1.06	2.36
Delta hedged excess returns	Out of the money	0.20	0.40	**-17.27**	**-8.28**	**-2.89**	-1.30	-0.01	0.80
	At the money	0.40	0.60	**-9.89**	**-5.22**	-1.21	-0.86	-0.27	0.17
	In the money	0.60	0.80	**-5.09**	**-2.50**	-0.65	-0.41	-0.01	0.28
	Deep in the money	0.80	1.00	**-3.00**	-0.73	-0.62	0.18	0.55	**0.56**
Panel F	Deep out of the money	0.00	0.20	-3.76	-1.98	-1.25	-0.42	0.51	1.65
t-statistics	Out of the money	0.20	0.40	-8.38	-4.38	-2.02	-1.12	-0.01	1.08
Delta hedged excess returns	At the money	0.40	0.60	-7.97	-5.38	-1.53	-1.35	-0.48	0.35
	In the money	0.60	0.80	-7.45	-5.01	-1.63	-1.23	-0.02	1.02
	Deep in the money	0.80	1.00	-5.63	-1.87	-1.54	0.69	1.32	2.19

Index Put Options		Abs(delta) range		Maturity (months)					
				1	2	3	6	12	>12
Panel G	Deep out of the money	0.00	0.20	28.00	19.10	15.11	11.54	8.35	5.64
Embedded leverage	Out of the money	0.20	0.40	26.05	17.44	13.91	10.50	7.57	5.01
	At the money	0.40	0.60	22.71	15.36	12.39	9.46	6.81	4.66
	In the money	0.60	0.80	18.98	12.77	10.49	8.04	5.79	4.19
	Deep in the money	0.80	1.00	13.05	9.43	7.74	5.90	4.39	3.43
Panel H	Deep out of the money	0.00	0.20	**-30.23**	**-15.83**	**-9.95**	-3.57	-0.11	1.13
Delta hedged excess returns	Out of the money	0.20	0.40	**-17.82**	**-10.57**	**-6.84**	**-2.68**	-0.60	0.47
	At the money	0.40	0.60	**-9.53**	**-6.67**	**-4.16**	**-1.72**	-0.38	0.35
	In the money	0.60	0.80	**-4.94**	**-3.13**	**-1.87**	-0.88	-0.63	0.16
	Deep in the money	0.80	1.00	**-3.22**	**-2.05**	-0.52	-0.47	-0.47	-0.52
Panel I	Deep out of the money	0.00	0.20	-4.45	-3.35	-2.45	-1.18	-0.05	0.69
t-statistics	Out of the money	0.20	0.40	-6.03	-5.08	-3.82	-2.02	-0.59	0.56
Delta hedged excess returns	At the money	0.40	0.60	-5.37	-5.75	-3.71	-2.22	-0.63	0.64
	In the money	0.60	0.80	-4.85	-4.72	-2.55	-1.87	-1.73	0.33
	Deep in the money	0.80	1.00	-4.87	-3.83	-0.82	-1.37	-1.49	-1.51

Table A4
Robustness Analysis: BAB Portfolios, Alternative Risk Adjustments

This table shows calendar-time portfolio returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio and $r_t^{H,i}$ and $r_t^{L,i}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for each security. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low leverage (unlevered ETFs) and high leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^{ETFs,i} = r_t^{1x,i} - 0.5 * r_t^{2x,i}$ where $r_t^{1x,i}$ is the excess return on the unlevered ETF and $r_t^{2x,i}$ is the excess return of the levered ETF. The ETF BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios and it is rebalanced daily to maintain equal weights. The asterisk * in the ETF sample indicates that expenses ratios have been added back to the returns of the fund. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010. Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles. Alphas are in monthly percent and 5% statistical significance is indicated in bold.

Panel A: Equity Options		Alpha			t-statistics		
		All	Calls	Puts	All	Calls	Puts
All	Capm	**0.36**	**0.29**	**0.42**	8.46	7.62	6.51
	3-Factor model	**0.36**	**0.30**	**0.43**	8.50	7.76	6.48
	4-Factor model	**0.38**	**0.30**	**0.45**	8.66	7.65	6.75
	5-Factor model	**0.33**	**0.26**	**0.40**	7.60	6.58	5.86
At-the-money	Capm	**0.35**	**0.28**	**0.41**	7.97	6.32	7.94
	3-Factor model	**0.36**	**0.30**	**0.42**	8.35	6.72	8.21
	4-Factor model	**0.37**	**0.30**	**0.44**	8.39	6.57	8.42
	5-Factor model	**0.36**	**0.28**	**0.44**	7.83	5.96	8.01
Panel B: Index Options		All	Calls	Puts	All	Calls	Puts
All	Capm	**0.32**	**0.22**	**0.43**	6.19	5.12	4.95
	3-Factor model	**0.32**	**0.22**	**0.43**	6.07	5.06	4.85
	4-Factor model	**0.33**	**0.21**	**0.45**	6.14	4.88	5.03
	5-Factor model	**0.26**	**0.15**	**0.37**	4.95	3.58	4.10
At-the-money	Capm	**0.24**	**0.20**	**0.29**	4.47	3.89	4.37
	3-Factor model	**0.25**	**0.20**	**0.30**	4.48	3.86	4.41
	4-Factor model	**0.24**	**0.19**	**0.30**	4.33	3.65	4.32
	5-Factor model	**0.19**	**0.14**	**0.25**	3.41	2.71	3.51
Panel C: ETFs			All	All*		All	All*
	Capm		**0.08**	**0.06**		3.29	2.35
	3-Factor model		**0.08**	**0.06**		3.32	2.37
	4-Factor model		**0.09**	**0.06**		3.45	2.49
	5-Factor model		**0.09**	**0.07**		3.43	2.52

Table A5
Robustness Analysis: BAB Portfolios, Sub-Samples

This table shows calendar-time portfolio returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio and $r_t^{H,i}$ and $r_t^{L,i}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for each security. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low leverage (unlevered ETFs) and high leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^{ETFs,i} = r_t^{1x,i} - 0.5 * r_t^{2x,i}$ where $r_t^{1x,i}$ is the excess return on the unlevered ETF and $r_t^{2x,i}$ is the excess return of the levered ETF. The ETF BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios and it is rebalanced daily to maintain equal weights. The asterisk * in the ETF sample indicates that expenses ratios have been added back to the returns of the fund. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010. Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles. Alphas are in monthly percent and 5% statistical significance is indicated in bold.

Panel A: Equity Options		Alpha			t-statistics		
		All	Calls	Puts	All	Calls	Puts
All options	1996 - 1999	**0.36**	**0.20**	**0.52**	4.37	3.57	3.75
	2000 - 2005	**0.35**	**0.31**	**0.39**	5.00	3.91	4.44
	2006 - 2010	**0.29**	**0.26**	**0.33**	3.61	4.26	2.33
At-the-money	1996 - 1999	**0.35**	**0.34**	**0.37**	3.39	3.67	2.88
	2000 - 2005	**0.33**	**0.25**	**0.41**	4.51	3.12	4.55
	2006 - 2010	**0.34**	**0.24**	**0.44**	4.14	3.03	4.67
Panel B: Index Options		All	Calls	Puts	All	Calls	Puts
All options	1996 - 1999	**0.47**	0.13	**0.81**	4.75	1.90	4.29
	2000 - 2005	**0.15**	0.11	0.18	2.11	1.72	1.56
	2006 - 2010	**0.27**	**0.21**	0.32	2.44	2.49	1.75
At-the-money	1996 - 1999	**0.42**	**0.42**	**0.41**	3.08	3.54	2.55
	2000 - 2005	0.01	-0.03	0.05	0.08	-0.49	0.45
	2006 - 2010	**0.22**	0.14	**0.31**	2.09	1.33	2.55
Panel C: ETFs			All	All*			
	2006 - 2007		0.07	0.07		1.49	1.93
	2008 - 2010		**0.10**	**0.09**		1.99	2.59

* Expenses ratios have been added back to the return of the fund

Table A6
Robustness Analysis: BAB Option Portfolios by Moneyness and Maturity

This table shows calendar-time portfolio returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio and $r_t^{H,i}$ and $r_t^{L,i}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for each security. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010. Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles. Alphas are in monthly percent and 5% statistical significance is indicated in bold.

Panel A: Equity Options		Alpha			t-statistics		
		All	Calls	Puts	All	Calls	Puts
Maturity	Moneyness						
Long-dated	All	-0.02	-0.03	-0.02	-0.52	-0.53	-0.33
Short-dated	All	**0.30**	**0.44**	0.15	6.31	8.21	1.76
All	At-the-money	**0.36**	**0.28**	**0.44**	7.83	5.96	8.01
All	In the money	**0.26**	**0.18**	**0.35**	8.51	5.19	7.74
All	Deep in the money	**0.11**	**0.07**	0.15	2.04	2.40	1.44
All	Out of the money	**0.55**	**0.45**	**0.65**	8.82	6.63	9.40
All	Deep out of the money	**0.72**	**0.61**	**0.84**	6.98	6.18	5.77

Panel B: Index Options		All	Calls	Puts	All	Calls	Puts
Maturity	Moneyness						
Long-dated	All	**0.10**	0.01	**0.20**	2.48	0.34	2.70
Short-dated	All	**0.11**	**0.25**	-0.02	2.35	3.81	-0.24
All	At-the-money	**0.19**	**0.14**	**0.25**	3.41	2.71	3.51
All	In the money	**0.11**	0.08	**0.15**	3.61	1.91	3.40
All	Deep in the money	**0.06**	0.04	0.08	2.66	1.58	1.70
All	Out of the money	**0.39**	**0.30**	**0.48**	5.11	3.63	5.62
All	Deep out of the money	**0.71**	**0.56**	**0.85**	5.40	4.23	4.66

Table A7
Robustness Analysis: BAB Portfolios, Equity Call Options on Non-Dividend Payers

This table shows calendar-time portfolio returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio and $r_t^{H,i}$ and $r_t^{L,i}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for each security. This table includes all available options Non-dividend payers on the domestic OptionMetrics Ivy database between 1996 and 2010. Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles. "Frac (Alpha >0)" is equal to the fraction of assets with positive abnormal returns. "No dividend in full sample" indicates the securities that never paid dividends over the full sample. "No dividend prior to portfolio formation" indicates securities that never paid dividends as of portfolio formation date. Returns and Alphas are in monthly percent, t-statistics are shows below the coefficient estimates and 5% statistical significance is indicated in bold. Volatilities and Sharpe ratios are annualized.

	All Calls		At-the-Money Calls	
	No dividend in Full sample	No dividend prior to portoflio formation	No dividend in Full sample	No dividend prior to portoflio formation
Excess return %	**0.47**	**0.29**	**0.44**	**0.42**
	(5.72)	(2.89)	(5.58)	(3.37)
5-factor alpha %	**0.41**	**0.22**	**0.44**	**0.50**
	(4.71)	(2.10)	(5.36)	(3.77)
Frac (Alpha >0)	0.75	0.74	0.70	0.70
MKT	-0.01	-0.02	**-0.04**	**-0.06**
	-(0.56)	-(0.81)	-(2.39)	-(2.07)
SMB	0.02	-0.02	0.01	-0.03
	(0.59)	-(0.58)	(0.43)	-(0.64)
HML	-0.01	0.01	-0.03	-0.05
	-(0.24)	(0.33)	-(1.25)	-(1.26)
UMD	0.02	-0.03	0.02	-0.03
	(1.30)	-(1.29)	(1.37)	-(1.12)
Straddle	-0.01	**-0.01**	0.00	0.00
	-(1.59)	-(2.31)	-(0.46)	(0.31)
Leverage short	4.92	3.93	5.54	4.75
Leverage long	10.17	7.82	10.21	8.00
Dollar Short	0.24	0.31	0.21	0.26
Dollar Long	0.12	0.15	0.13	0.16
Volatility	3.82	4.65	3.63	5.83
Sharpe ratio	1.48	0.75	1.44	0.87

Table A8
Robustness Analysis: BAB Portfolios, Alternative Risk-Free Rates

This table shows calendar-time portfolio returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio and $r_t^{H,i}$ and $r_t^{L,i}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for each security. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low leverage (unlevered ETFs) and high leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^{ETFs,i} = r_t^{1x,i} - 0.5 * r_t^{2x,i}$ where $r_t^{1x,i}$ is the excess return on the unlevered ETF and $r_t^{2x,i}$ is the excess return of the levered ETF. The ETF BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios and it is rebalanced daily to maintain equal weights. The asterisk * in the ETF sample indicates that expenses ratios have been added back to the returns of the fund. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010. We report returns using different risk free rates sorted by their average spread over the Treasury bill. "T-bills" is the 1-month Treasury bills. "Repo" is the overnight repo rate. "OIS" is the overnight indexed swap rate. "Fed Funds" is the effective federal funds rate. "Libor" is the 1-month and 3-month LIBOR rate. If the interest rate is not available over a date range, we use the 1-month Treasury bills plus the average spread over the entire sample period. Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles. Alphas are in monthly percent and 5% statistical significance is indicated in bold.

Panel A: Equity Options		Alpha			t-statistics		
	Average Spread (Annual , Bps)	All	Calls	Puts	All	Calls	Puts
T-Bills	0.0	**0.33**	**0.26**	**0.40**	7.60	6.58	5.86
Repo	18.3	**0.32**	**0.25**	**0.39**	7.43	6.40	5.75
OIS	23.3	**0.32**	**0.25**	**0.39**	7.43	6.40	5.74
Fed Funds	23.4	**0.32**	**0.25**	**0.39**	7.42	6.38	5.74
Libor 1M	44.9	**0.31**	**0.25**	**0.38**	7.29	6.28	5.63
Libor 3M	54.5	**0.31**	**0.24**	**0.38**	7.22	6.23	5.58
Panel B: Index Options		All	Calls	Puts	All	Calls	Puts
T-Bills	0.0	**0.26**	**0.15**	**0.37**	4.95	3.58	4.10
Repo	18.3	**0.26**	**0.15**	**0.37**	4.87	3.47	4.05
OIS	23.3	**0.26**	**0.15**	**0.37**	4.86	3.46	4.04
Fed Funds	23.4	**0.26**	**0.15**	**0.37**	4.86	3.46	4.05
Libor 1M	44.9	**0.25**	**0.14**	**0.36**	4.79	3.40	4.00
Libor 3M	54.5	**0.25**	**0.14**	**0.36**	4.76	3.36	3.97
Panel C: ETFs			All	All*		All	All*
T-Bills	0.0		**0.09**	**0.07**		3.43	2.52
Repo	18.3		**0.07**	0.05		2.54	1.66
OIS	23.3		**0.06**	0.04		2.28	1.41
Fed Funds	23.4		**0.07**	0.04		2.40	1.52
Libor 1M	44.9		0.04	0.01		1.43	0.51
Libor 3M	54.5		0.03	0.00		0.99	0.05

* Expenses ratios have been added back to the return of the fund

Figure A1
Embedded Leverage and Excess Delta-Hedged Returns across Maturity and Delta, Calls

This figure shows average excess returns of portfolios of options based on maturity and delta. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolio based on the option expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. This figure includes all available call options on the domestic OptionMetrics Ivy database between 1996 and 2010 and shows average excess returns and means embedded leverage for each of the 30 portfolios. Embedded leverage is defined as $\Omega = |\Delta S/F|$ where Δ is the option delta, F is the option price and S is the spot price. Returns are in monthly percent. "Linear" is a fitted cross sectional regression.

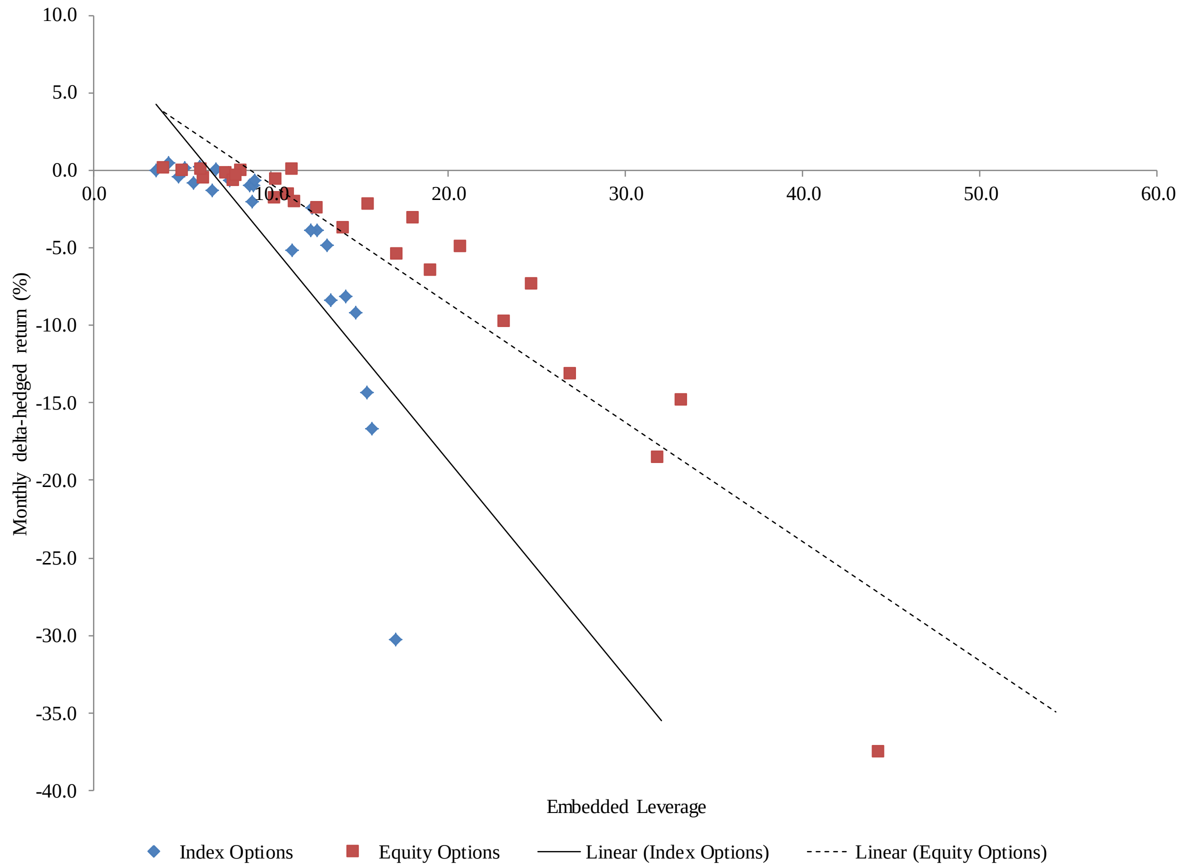

Figure A2
Embedded Leverage and Excess Delta-Hedged Returns across Maturity and Delta, Puts

This figure shows average excess returns of portfolios of options based on maturity and delta. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolio based on the option expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. This figure includes all available put options on the domestic OptionMetrics Ivy database between 1996 and 2010 and shows average excess returns and means embedded leverage for each of the 30 portfolios. Embedded leverage is defined as $\Omega = |\Delta S/F|$ where Δ is the option delta, F is the option price and S is the spot price. Returns are in monthly percent. “Linear” is a fitted cross sectional regression.

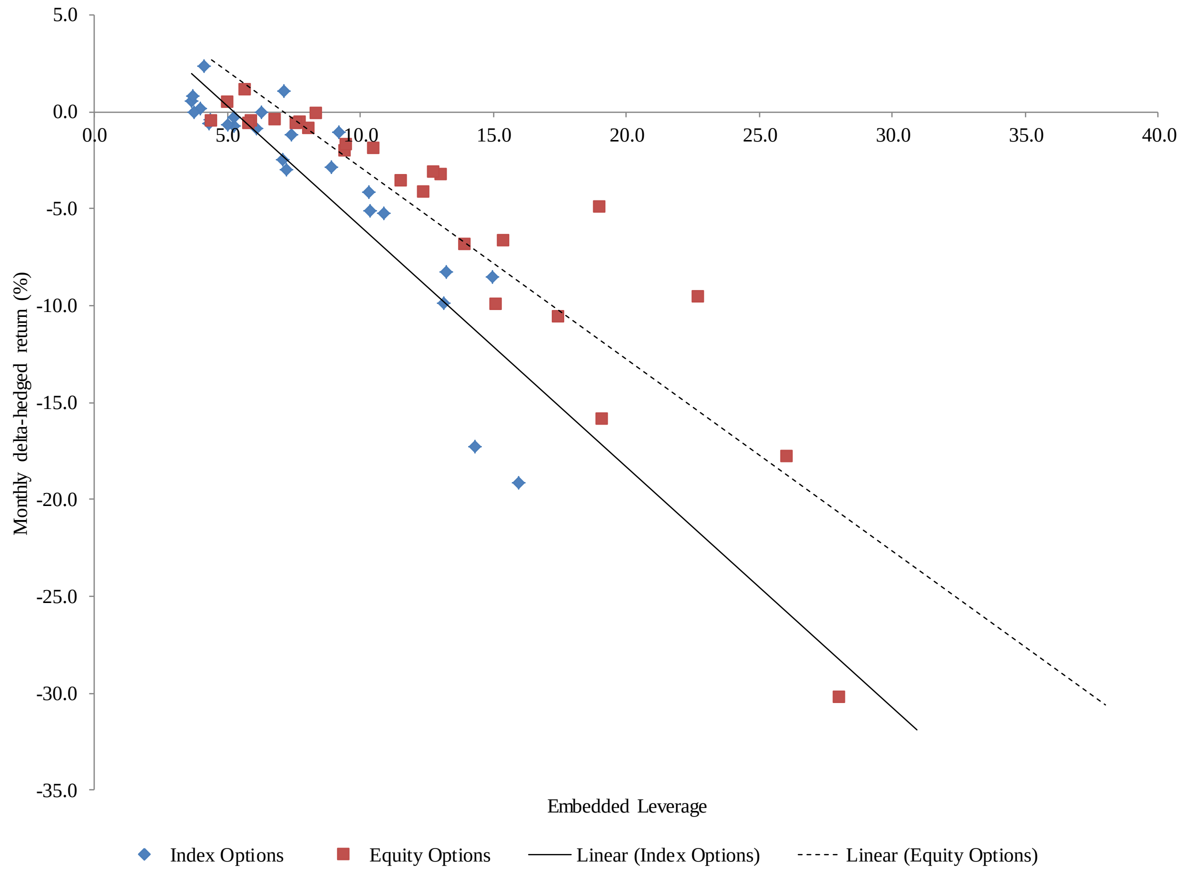

Figure A3
Annual Returns of Betting-Against-Beta portfolios: All Options and ETFs

This figure shows annual returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low embedded leverage portfolio and shorts the high embedded leverage portfolio: $BAB_{t,i} = (1/\phi^{L}_{t-1,i})\, r^{L}_{i,t} - (1/\phi^{H}_{t-1,i})\, r^{H}_{i,t}$ where ϕ_i and ϕ^{L}_{i} are the embedded leverage of the value-weighted H and L portfolio for security i, and $r^{H}_{i,t}$ and $r^{L}_{i,t}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for security i. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low embedded leverage (unlevered ETFs) and high embedded leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low embedded leverage portfolio and shorts the high embedded leverage portfolio: $BAB^{ETFs}_{i,t} = r^{1x}_{i,t} - 0.5 * r^{2x}_{i,t}$ where $r^{1x}_{i,t}$ is the excess return on the unlevered ETF and $r^{2x}_{i,t}$ is the excess returns of the levered ETF. The ETFs BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios. The ETF BAB portfolio is rebalanced daily to maintain equal weights. This figure includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010.

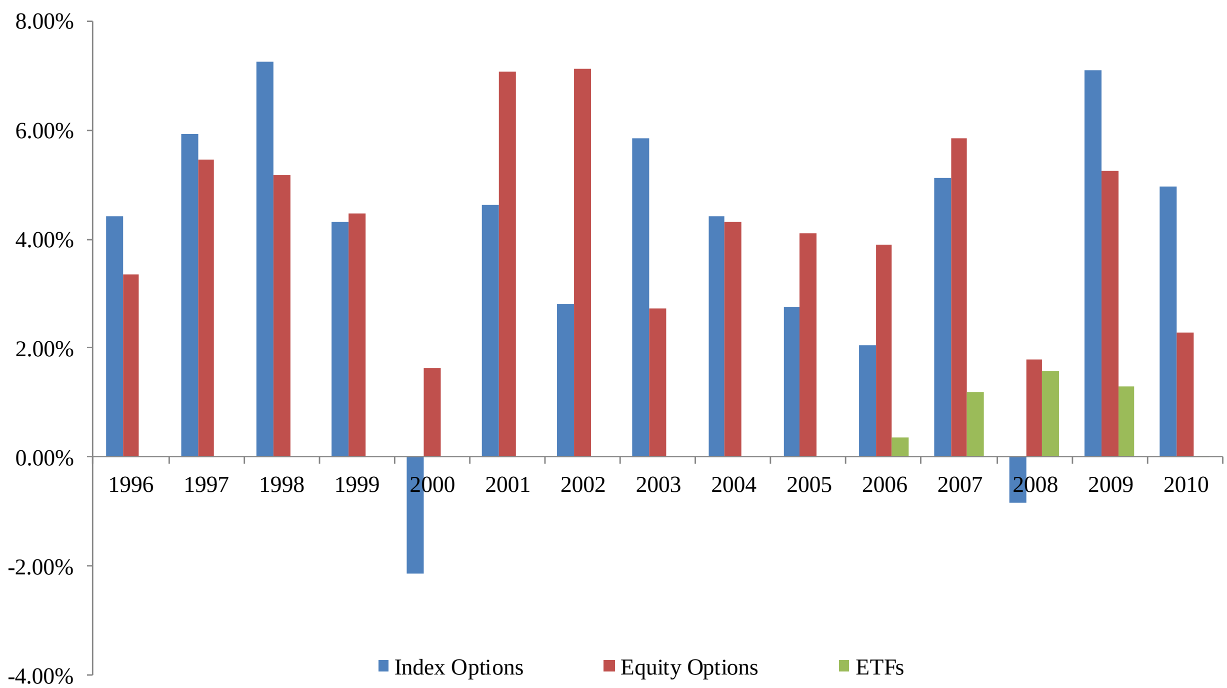

Figure A4
Annual Returns of Betting-Against-Beta portfolios: At-The-Money Options

This figure shows annual returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low embedded leverage portfolio and shorts the high embedded leverage portfolio: $BAB_{t,i} = (1/\phi_{t-1,i}^{L})\, r_{i,t}^{L} - (1/\phi_{t-1,i}^{H})\, r_{i,t}^{H}$ where ϕ_i and ϕ_i^L are the embedded leverage of the value-weighted H and L portfolio for security i, and $r_{i,t}^{H}$ and $r_{i,t}^{L}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for security i. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low embedded leverage (unlevered ETFs) and high embedded leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low embedded leverage portfolio and shorts the high embedded leverage portfolio: $BAB_{i,t}^{ETFs} = r_{i,t}^{1x} - 0.5 * r_{i,t}^{2x}$ where $r_{i,t}^{1x}$ is the excess return on the unlevered ETF and $r_{i,t}^{2x}$ is the excess returns of the levered ETF. The ETFs BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios. The ETF BAB portfolio is rebalanced daily to maintain equal weights. This figure includes all at-the-money options on the domestic OptionMetrics Ivy database between 1996 and 2010.

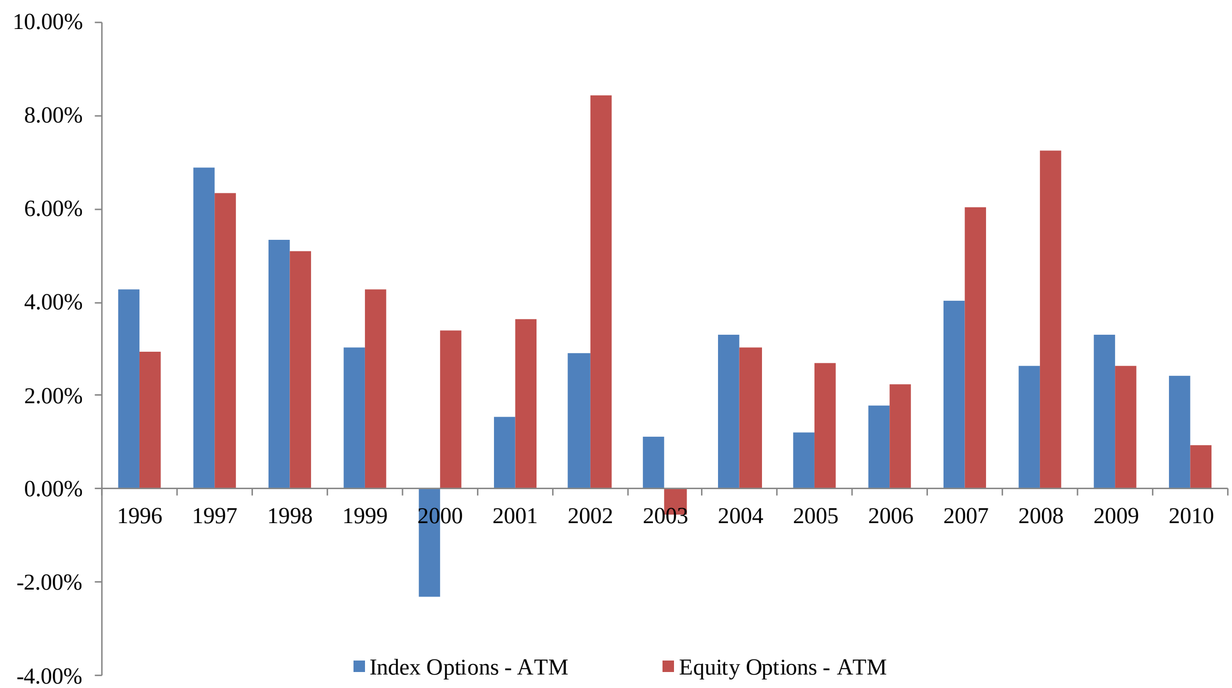

Table I
Sample Description

This table reports the list of instruments included in our three samples – the equity option sample, the index option sample and the exchange-traded funds samples (ETF) – and the corresponding date ranges. The table also report ticker symbols and expense ratios (in basis points).

Equity Option Sample					Start Year	End Year
All domestic equity options on OptionMetrics Ivy DB					1996	2010
Index Option Sample	**Ticker (latest)**				**Start Year**	**End Year**
NYSE ARCA Major Market	XMI				1996	2008
S&P Midcap 400	MID				1996	2010
Russell 2000	RUT				1996	2010
S&P SmallCap 600	SML				1996	2010
Dow Jones	DJX				1997	2010
Nasdaq 100	NDX				1996	2010
Mini-NDX	MNX				2000	2010
CBOE Int Rate 30 Yr T Bond	TYX				1996	2010
NYSE Composite Old	NYZ				1996	2003
S&P 500	SPX				1996	2010
Wilshire Small Cap	WSX				1996	1999
S&P 100	OEX				1996	2010
ETF Sample	**Ticker (latest)**		**Expense ratio (Basis Points)**		**Start Year**	**End Year**
	1x	2x	1x	2x		
Dow Jones	DIA	DDM	17	95	2006	2010
S&P Mid Cap 400	MDY	MVV	25	95	2006	2010
Nasdaq 100	QQQQ	QLD	20	95	2006	2010
Russell 2000	IWM	UWM	20	95	2007	2010
Russell 3000	IWV	UWC	20	95	2009	2010
S&P 500	SPY	SSO	9	92	2006	2010
S&P SmallCap 600	IJR	SAA	20	95	2007	2010

Table II
Summary Statistics

This table shows summary statistics. "Option maturity" is the option's time to expiration, in months. "Embedded leverage" is defined as $\Omega = |\Delta S/F|$ where Δ is the security's delta, F is the security's price and S is the price of the underlying. "Moneyness" is defined as the ratio of (S-X) / S for call options and (X-S)/S for put options where X is the option strike price. "Implied volatility" is the option implied volatility computed using Cox, Ross, and Rubinstein (1979) binomial tree model. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010.

		Mean	Median	Std	Min	Max
Equity options	Number of stocks per year	2,920	2,929	418	2,172	3,519
	Number of options per year	262,903	225,489	94,961	131,551	458,604
	Number of options per stock-month	62	40	74	1	826
	Option maturity (months)	6.47	5.00	6.32	1.00	38.00
	Embedded leverage	6.48	5.09	4.79	0.14	43.94
	Moneyness	-0.08	-0.04	0.34	-47.24	1.92
	Implied volatility	0.50	0.44	0.25	0.02	4.58
Index options	Number of indices per year	10	10	1	9	11
	Number of options per year	6,387	4,957	2,727	3,490	11,856
	Number of options per index-month	371	335	234	1	1,048
	Option maturity (months)	7.02	4.00	7.08	1.00	38.00
	Embedded leverage	12.14	8.90	10.15	0.72	120.60
	Moneyness	-0.07	-0.04	0.32	-21.18	1.25
	Implied volatility	0.28	0.25	0.12	0.05	1.58
ETFs	Number of ETFs per year	6	6	1	4	7

Table III
Embedded Leverage and Excess Returns across Maturity and Moneyness

This table shows calendar-time portfolio returns and summary statistics of option portfolios based on maturity and moneyness. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option's delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolios based on the option's expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio and average them. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010. "Embedded leverage" is defined as $\Omega = |\Delta S/F|$ where Δ is the option delta, F is the option price and S is the spot price. Returns are monthly in percent, and 5% statistical significance is indicated in bold.

Equity Options		Abs(delta) range		Maturity (months)					
				1	2	3	6	12	>12
Panel A	Deep out of the money	0.00	0.20	16.48	15.18	11.83	11.15	9.72	5.88
Embedded leverage	Out of the money	0.20	0.40	14.99	13.70	10.01	8.75	7.67	4.65
	At the money	0.40	0.60	13.97	11.54	8.16	6.84	6.04	3.69
	In the money	0.60	0.80	11.45	8.04	5.84	5.13	4.42	2.85
	Deep in the money	0.80	1.00	7.98	5.60	4.53	4.08	3.54	2.42
Panel B	Deep out of the money	0.00	0.20	**-24.71**	**-11.43**	**-6.27**	-2.96	-0.70	0.86
Delta hedged excess returns	Out of the money	0.20	0.40	**-16.98**	**-8.19**	**-4.03**	-1.46	-0.31	-0.01
	At the money	0.40	0.60	**-9.53**	**-4.56**	**-1.64**	-0.54	-0.11	-0.05
	In the money	0.60	0.80	**-4.49**	**-1.73**	**-0.99**	-0.07	0.06	0.17
	Deep in the money	0.80	1.00	**-2.00**	-0.26	-0.50	0.31	0.28	0.31
Panel C	Deep out of the money	0.00	0.20	-8.26	-3.82	-2.53	-1.37	-0.36	0.57
t-statistics	Out of the money	0.20	0.40	-9.88	-4.98	-3.18	-1.29	-0.31	-0.01
Delta hedged excess returns	At the money	0.40	0.60	-8.58	-5.05	-2.18	-0.84	-0.18	-0.10
	In the money	0.60	0.80	-8.43	-3.83	-2.60	-0.21	0.18	0.64
	Deep in the money	0.80	1.00	-5.79	-0.94	-1.92	1.56	1.12	1.92

Index Options		Abs(delta) range		Maturity (months)					
				1	2	3	6	12	>12
Panel D	Deep out of the money	0.00	0.20	36.14	25.46	20.60	16.07	11.82	8.17
Embedded leverage	Out of the money	0.20	0.40	29.61	20.28	16.44	12.66	9.37	6.51
	At the money	0.40	0.60	23.69	16.24	13.30	10.19	7.55	5.28
	In the money	0.60	0.80	18.48	12.68	10.41	7.95	5.91	4.35
	Deep in the money	0.80	1.00	11.64	8.38	6.92	5.30	4.07	3.27
Panel E	Deep out of the money	0.00	0.20	**-33.87**	**-17.17**	**-11.74**	-4.23	-1.09	-0.28
Delta hedged excess returns	Out of the money	0.20	0.40	**-16.33**	**-10.15**	**-6.61**	-2.42	-0.28	0.07
	At the money	0.40	0.60	**-8.42**	**-6.02**	**-3.77**	**-1.61**	-0.20	0.10
	In the money	0.60	0.80	**-4.00**	**-2.77**	**-1.74**	-0.77	-0.31	0.06
	Deep in the money	0.80	1.00	**-1.86**	**-1.05**	-0.64	-0.13	0.01	-0.07
Panel F	Deep out of the money	0.00	0.20	-6.70	-4.20	-3.30	-1.45	-0.50	-0.16
t-statistics	Out of the money	0.20	0.40	-6.01	-4.99	-3.69	-1.68	-0.25	0.07
Delta hedged excess returns	At the money	0.40	0.60	-5.06	-5.33	-3.41	-2.04	-0.32	0.19
	In the money	0.60	0.80	-4.80	-4.60	-2.75	-1.82	-0.91	0.20
	Deep in the money	0.80	1.00	-5.01	-3.31	-1.40	-0.71	0.05	-0.44

Table IV
Excess Returns and Alphas of Asset Classes with Embedded Leveraged Assets

This table shows calendar-time returns of portfolios of options and levered ETFs. The top and middle part of each panel report option returns. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option's delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolios based on the option's expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio. We average all portfolios to compute aggregate options returns. Panel A reports equal-weighted averages of the 30 option portfolios. Panel B reports value-weighted averages of the 30 portfolios. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010. "Excess return" is the delta-hedged return in excess of the Treasury Bills rate. The bottom part of each panel reports levered ETFs returns obtained by averaging the return of the levered ETFs in our sample. The ETF regression is run daily, but results are reported in monthly percent. This table includes all available levered ETFs between 2006 and 2010 "Excess return" is the return in excess of the Treasury Bills rate. Alpha is the intercept in a regression of monthly excess return. The asterisk * in the ETF sample indicates that expenses ratios have been added back to the returns of the fund. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios and Carhart (1997) momentum factor. Returns and alphas are in monthly percent and 5% statistical significance is indicated in bold.

Panel A: Equally Weighted		Alpha			t-statistics		
		All	Calls	Puts	All	Calls	Puts
Equity Options	Excess return	**-4.80**	**-4.68**	**-4.92**	-3.90	-3.56	-3.77
	CAPM	**-4.07**	**-3.96**	**-4.18**	-3.77	-3.36	-3.60
	3-Factor model	**-3.75**	**-3.61**	**-3.88**	-3.52	-3.12	-3.35
	4-Factor model	**-3.25**	**-3.22**	**-3.29**	-3.04	-2.75	-2.84
Index Options	Excess return	**-3.47**	**-3.92**	**-3.02**	-3.91	-4.79	-2.93
	CAPM	**-2.89**	**-3.47**	**-2.31**	-3.84	-4.73	-2.72
	3-Factor model	**-2.65**	**-3.19**	**-2.10**	-3.58	-4.45	-2.49
	4-Factor model	**-2.37**	**-3.00**	**-1.74**	-3.18	-4.12	-2.05
			All	All*		All	All*
Levered ETFs	Excess return		0.73	0.80		0.34	0.38
	CAPM		-0.11	-0.04		-0.18	-0.06
	3-Factor model		-0.37	-0.30		-0.75	-0.59
	4-Factor model		-0.43	-0.35		-0.88	-0.72

Panel B: Value Weighted		Alpha			t-statistics		
		All	Calls	Puts	All	Calls	Puts
Equity Options	Excess return	**-1.57**	**-1.28**	**-1.86**	-2.31	-2.46	-2.05
	CAPM	**-1.13**	**-1.01**	-1.25	-1.96	-2.14	-1.65
	3-Factor model	-0.94	-0.81	-1.07	-1.66	-1.76	-1.43
	4-Factor model	-0.69	-0.72	-0.66	-1.21	-1.54	-0.88
Index Options	Excess return	**-2.40**	**-1.53**	**-3.26**	-2.75	-2.11	-2.85
	CAPM	**-1.91**	-1.15	**-2.67**	-2.46	-1.75	-2.56
	3-Factor model	**-1.68**	-0.92	**-2.43**	-2.19	-1.44	-2.34
	4-Factor model	-1.27	-0.80	-1.73	-1.65	-1.23	-1.68
			All	All*		All	All*
Levered ETFs	Excess return		0.73	0.80		0.34	0.38
	CAPM		-0.11	-0.04		-0.18	-0.06
	3-Factor model		-0.37	-0.30		-0.75	-0.59
	4-Factor model		-0.43	-0.35		-0.88	-0.72

* Expenses ratios have been added back to the return of the fund

Table V
Alphas of Maturity-Sorted and Delta-Sorted Option Portfolios

This table shows calendar-time portfolio return. Each calendar month, on the first trading day following expiration Saturday, we assign all options to 1 of 30 portfolios that are the interception of 5 portfolios based on the option delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolio based on the option expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced monthly to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio and average them. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010. The top panel reports results for portfolios sorted by maturity. To compute the excess return for each maturity bucket, we average the excess return across the 5 corresponding delta-sorted portfolios. P6-P1 is a self-financing portfolio that is long long-maturity options and short short-maturity options. The bottom panel reports results for portfolios sorted by delta. To compute the excess return for each delta bucket we average the excess return across the 6 corresponding maturity-sorted portfolios. P5-P1 is a self-financing portfolio that is long in-the-money options and short out-of-the-money options. "Excess return" is the delta-hedged return in excess of the Treasury Bills rate. Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles. Returns and alphas are in monthly percent and 5% statistical significance is indicated in bold.

Panel A: Equity Options			Returns			t-statistics		
		Embedded Leverage	Excess return	4-factor alpha	5-factor alpha	Excess return	4-factor alpha	5-factor alpha
Portfolio	Maturity (months)							
P1	1	12.97	-11.54	-10.39	-7.99	-9.76	-9.45	-8.70
P2	2	10.81	-5.24	-3.98	-1.50	-4.34	-3.73	-1.74
P3	3	8.07	-2.68	-1.32	0.32	-2.71	-1.62	0.45
P4	6	7.19	-0.94	0.11	1.63	-1.08	0.15	2.56
P5	12	6.28	-0.16	0.80	2.09	-0.20	1.23	3.55
P6	>12	3.90	0.25	1.03	1.78	0.41	1.97	3.61
P1 - P6		-8.92	**11.49**	**11.08**	**9.57**	12.75	12.08	11.48
Portfolio	Moneyness							
P1	Deep out of the money	11.76	-7.70	-5.25	-1.54	-3.66	-2.95	-1.00
P2	Out of the money	10.01	-5.25	-3.75	-1.37	-4.45	-3.76	-1.74
P3	At the money	8.41	-2.79	-1.89	-0.45	-4.05	-3.22	-0.98
P4	In the money	6.32	-1.21	-0.78	-0.12	-3.51	-2.71	-0.52
P5	Deep in the money	4.71	-0.33	-0.12	0.14	-1.69	-0.71	0.87
P1 - P5		-7.05	**7.37**	**5.13**	1.68	3.79	3.11	1.17

Panel B: Index Options			Returns			t-statistics		
		Embedded Leverage	Excess return	4-factor alpha	5-factor alpha	Excess return	4-factor alpha	5-factor alpha
Portfolio	Maturity (months)							
P1	1	23.91	-12.89	-10.68	-5.73	-6.61	-5.98	-5.01
P2	2	16.61	-7.43	-5.52	-1.85	-4.74	-3.97	-1.83
P3	3	13.76	-5.09	-3.33	-0.28	-3.50	-2.60	-0.27
P4	6	10.43	-1.83	-0.54	1.66	-1.63	-0.54	1.96
P5	12	7.74	-0.37	0.62	2.05	-0.43	0.81	2.95
P6	>12	5.52	-0.03	0.83	1.77	-0.05	1.33	2.92
P1 - P6		-18.39	**12.86**	**11.52**	**7.50**	7.99	7.29	6.69
Portfolio	Moneyness							
P1	Deep out of the money	19.70	-11.42	-7.79	-1.88	-3.83	-3.01	-0.89
P2	Out of the money	15.81	-5.95	-4.05	-0.24	-3.83	-2.94	-0.26
P3	At the money	12.71	-3.33	-2.24	0.09	-3.69	-2.77	0.17
P4	In the money	9.96	-1.59	-1.00	0.10	-3.36	-2.42	0.35
P5	Deep in the money	6.60	-0.62	-0.36	0.00	-2.95	-1.93	0.01
P1 - P6		-13.10	**10.80**	**7.43**	1.88	3.84	3.03	0.93

Table VI

BAB Portfolios, 1996 – 2010

This table shows calendar-time portfolio returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio and $r_t^{H,i}$ and $r_t^{L,i}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for each security. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low leverage (unlevered ETFs) and high leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^{ETFs,i} = r_t^{1x,i} - 0.5 * r_t^{2x,i}$ where $r_t^{1x,i}$ is the excess return on the unlevered ETF and $r_t^{2x,i}$ is the excess return of the levered ETF. The ETF BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios and it is rebalanced daily to maintain equal weights. The asterisk * in the ETF sample indicates that expenses ratios have been added back to the returns of the fund. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010. "Excess return" is the delta-hedged return in excess of the Treasury Bills rate (simple excess returns for ETFs). Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles."*Frac (Alpha >0)*" is equal to the fraction of assets with positive abnormal returns. Returns and Abnormal returns are in monthly percent, t-statistics are shown below the coefficient estimates and 5% statistical significance is indicated in bold. Volatilities and Sharpe ratios are annualized.

	Equity options						Index options						ETFs	
	All			At-the-Money			All			At-the-Money				
	All	Calls	Puts	All	Calls	Puts	All	Calls	Puts	All	Calls	Puts	All*	All
Excess return %	**0.36**	**0.29**	**0.43**	**0.33**	**0.26**	**0.40**	**0.33**	**0.22**	**0.43**	**0.23**	**0.18**	**0.28**	**0.06**	**0.09**
	(8.57)	(7.57)	(6.65)	(7.07)	(5.13)	(7.61)	(6.26)	(5.24)	(4.98)	(4.14)	(3.55)	(4.11)	(2.49)	(3.45)
5-factor alpha %	**0.33**	**0.26**	**0.40**	**0.36**	**0.28**	**0.44**	**0.26**	**0.15**	**0.37**	**0.19**	**0.14**	**0.25**	**0.07**	**0.09**
	(7.60)	(6.58)	(5.86)	(7.83)	(5.96)	(8.01)	(4.95)	(3.58)	(4.10)	(3.41)	(2.71)	(3.51)	(2.52)	(3.43)
Frac (Alpha >0)	0.78	0.78	0.70	0.77	0.74	0.74	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.86
MKT	-0.01	**-0.02**	-0.01	**-0.04**	**-0.06**	**-0.03**	-0.02	-0.01	-0.03	**-0.04**	**-0.04**	**-0.04**	0.00	0.00
	-(1.53)	-(2.44)	-(0.54)	-(4.45)	-(5.76)	-(2.54)	-(1.76)	-(1.00)	-(1.58)	-(3.26)	-(3.22)	-(2.88)	(0.51)	(0.53)
SMB	-0.01	-0.01	-0.01	**-0.03**	-0.03	**-0.04**	-0.01	0.00	-0.02	-0.01	-0.01	-0.02	0.00	0.00
	-(0.55)	-(0.58)	-(0.37)	-(2.20)	-(1.90)	-(2.06)	-(0.40)	(0.30)	-(0.61)	-(0.70)	-(0.55)	-(0.72)	(0.02)	(0.00)
HML	**-0.03**	**-0.03**	-0.03	**-0.03**	**-0.03**	-0.03	-0.02	-0.01	-0.02	-0.02	-0.01	-0.02	-0.01	-0.01
	-(2.45)	-(2.61)	-(1.60)	-(2.49)	-(2.66)	-(1.90)	-(1.08)	-(1.26)	-(0.67)	-(1.01)	-(0.61)	-(1.18)	-(1.66)	-(1.65)
UMD	**-0.02**	-0.01	**-0.03**	-0.01	0.00	-0.02	-0.02	0.00	-0.03	0.00	0.00	-0.01	0.00	0.00
	-(2.33)	-(1.05)	-(2.35)	-(1.11)	-(0.18)	-(1.70)	-(1.92)	-(0.60)	-(1.95)	-(0.25)	(0.14)	-(0.51)	-(0.67)	-(0.64)
Straddle	**-0.01**	**-0.01**	**-0.01**	0.00	0.00	0.00	**-0.01**	**-0.01**	**-0.01**	**-0.01**	**-0.01**	**-0.01**	0.00	0.00
	-(4.17)	-(4.35)	-(2.79)	-(0.71)	-(1.18)	-(0.18)	-(5.05)	-(5.67)	-(3.24)	-(3.15)	-(3.19)	-(2.72)	(0.96)	(0.98)
Ω long	4.61	4.57	4.66	4.77	5.39	4.16	6.69	6.39	6.99	7.01	7.46	6.55	1.00	1.00
Ω short	10.23	10.16	10.30	9.75	10.45	9.04	16.84	16.18	17.50	16.03	16.47	15.60	2.00	2.00
Dollar long	0.29	0.26	0.32	0.29	0.22	0.36	0.17	0.17	0.18	0.17	0.15	0.18	1.00	1.00
Dollar short	0.13	0.12	0.14	0.15	0.12	0.17	0.07	0.07	0.07	0.07	0.07	0.08	0.50	0.50
Volatility	1.95	1.78	3.01	2.15	2.31	2.44	2.42	1.97	4.00	2.57	2.38	3.12	0.63	0.63
Sharpe ratio	2.22	1.96	1.72	1.83	1.33	1.97	1.62	1.36	1.29	1.07	0.92	1.06	1.18	1.63

Table VII
Cross-Sectional Regressions

This table reports coefficients from Fama-MacBeth regressions. The dependent variable is the option delta-hedged excess return in month t or the ETF excess return on day t. The explanatory variables are the embedded leverage and a series of controls. For options "embedded leverage" is defined as $\Omega = |\Delta S/F|$ where Δ is the option delta, F is the option price and S is the spot price. "Total open interest" is the dollar open interest of all outstanding options for a given security. "Moneyness" is the ratio of (S-X) / S for call options and (X-S)/S for put options where X is the strike price. "x-Month spot volatility" is the standard deviation of the daily spot returns over the past *x* months. Stock return is the monthly spot return. Option turnover is defined as log(1 + volume/open interest). "Total option turnover" is defined as log(1+total volume / total open interest) where total volume is the sum of dollar volume of all outstanding options for a given security. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010. We report the average slope estimates (corresponding to average excess returns) or, when indicated by the "Risk Adjusted" flag, abnormal returns. Abnormal returns are the intercept on a regression of the monthly slope estimates (corresponding to monthly excess returns). The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles. Returns and alphas are in monthly percent. Standard errors are adjusted for heteroskedasticity and autocorrelation using a Bartlett kernel (Newey and West (1987)) with a maximum lag length of 12 months. T-statistics are shown below the coefficient estimates and 5% statistical significance is indicated in bold.

	Equity Options					Index Options					ETFs
Embedded Leverage (t-1)	**-0.72**	**-1.53**	**-1.57**	**-1.49**	**-1.28**	**-1.21**	**-1.43**	**-1.49**	**-1.51**	**-1.30**	**-0.26**
	-(5.40)	-(9.37)	-(10.52)	-(10.83)	-(10.08)	-(7.30)	-(8.57)	-(8.83)	-(9.20)	-(7.99)	-(2.35)
Log(open interest) (t-1)		**-0.52**	**1.00**	**0.90**	**0.89**		0.02	**0.29**	**0.34**	0.37	
		-(2.23)	(4.38)	(4.31)	(3.89)		(0.13)	(2.13)	(2.28)	(1.72)	
Log(total open interest) (t-1)		0.25	**-1.20**	-1.33	-1.25		0.47	**0.59**	0.17	1.23	
		(0.65)	-(2.10)	-(1.13)	-(1.18)		(1.78)	(3.53)	(0.15)	(0.76)	
Months to expiration (t-1)		**-1.27**	**-1.93**	**-1.82**	**-2.85**		-0.13	-0.39	-0.37	**-2.23**	
		-(2.02)	-(3.52)	-(3.20)	-(5.10)		-(0.18)	-(0.58)	-(0.57)	-(2.86)	
Moneyness (t-1)		**-0.24**	-0.03	-0.06	-0.06		**-0.19**	0.00	0.08	0.17	
		-(2.31)	-(0.22)	-(0.95)	-(0.89)		-(2.69)	-(0.03)	(0.82)	(1.13)	
Implied volatility (t-1)		**-36.28**	**-39.34**	**-38.47**	**-37.33**		-39.33	-47.49	**-48.21**	-16.90	
		-(7.36)	-(7.06)	-(4.41)	-(4.53)		-(1.30)	-(1.90)	-(1.97)	-(0.42)	
1-Month spot volatility (t-1)		3.77	2.07	-2.83	-2.55		21.63	34.35	**98.28**	75.48	
		(0.69)	(0.46)	-(0.73)	-(0.71)		(0.46)	(0.60)	(2.57)	(1.12)	
12-Month spot volatility (t-1)		**10.48**	5.91	**6.05**	**5.09**		-4.51	-55.76	**-152.22**	-137.16	
		(2.22)	(1.35)	(2.37)	(2.02)		-(0.08)	-(0.94)	-(3.41)	-(1.95)	
Option Vega (t-1)			**-0.03**	**-0.03**	**-0.05**			**-0.01**	**-0.02**	**-0.03**	
			-(2.20)	-(2.53)	-(3.31)			-(2.72)	-(3.42)	-(4.35)	
Option Gamma (t-1)			-0.33	**-0.28**	**-0.34**			**1.64**	**2.19**	**2.27**	
			-(1.44)	-(2.30)	-(2.89)			(3.33)	(3.91)	(3.60)	
Stock return (t)			-10.18	**-11.01**	**-13.25**			**93.25**	35.57	-4.95	
			-(1.79)	-(2.07)	-(2.86)			(2.64)	(0.59)	-(0.07)	
Option turnover (t)			**8.10**	**8.03**	**9.42**			0.98	1.05	2.02	
			(12.00)	(11.96)	(12.31)			(1.33)	(1.40)	(1.86)	
Total option turnover (t)			**9.02**	**11.47**	**11.77**			**3.09**	**3.41**	3.89	
			(2.82)	(4.21)	(4.76)			(2.61)	(1.97)	(1.64)	
Asset Fixed Effects	No	No	No	Yes	Yes	No	No	No	Yes	Yes	No
Risk Adjusted (5-factor)	No	No	No	No	Yes	No	No	No	No	Yes	Yes
Number of observations	11.3M	11.3M	11.3M	11.3M	11.3M	290K	290K	290K	290K	290K	13K

Table VIII
BAB and Factor Portfolios: Skewness and Kurtosis

This table shows calendar-time portfolio returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio and $r_t^{H,i}$ and $r_t^{L,i}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for each security. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low leverage (unlevered ETFs) and high leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^{ETFs,i} = r_t^{1x,i} - 0.5 * r_t^{2x,i}$ where $r_t^{1x,i}$ is the excess return on the unlevered ETF and $r_t^{2x,i}$ is the excess return of the levered ETF. The ETF BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios and it is rebalanced daily to maintain equal weights. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010. The "Factor" panel shows summary statistics of Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor (from Kenneth French's data library) and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles. Returns are in monthly percent. Volatilities and Sharpe ratios are annualized.

	Factors									BAB Portfolios				
	Full sample 1926 - 2010				Overlapping sample 1996 - 2010									
	MKT	SMB	HML	UMD	MKT	SMB	HML	UMD	Straddle	Equity	Equity (ATM)	Index	Index (ATM)	ETFs
Mean	0.62	0.25	0.39	0.70	0.50	0.33	0.23	0.58	-8.46	0.36	0.33	0.33	0.23	0.09
Volatility	0.19	0.12	0.12	0.17	0.19	0.13	0.11	0.20	0.88	0.02	0.02	0.02	0.03	0.01
Sharpe Ratio	0.40	0.26	0.38	0.50	0.32	0.34	0.22	0.42	-1.15	2.22	1.83	1.62	1.07	1.63
Min	-0.29	-0.17	-0.13	-0.51	-0.27	-0.12	-0.15	-0.27	-0.78	-0.03	-0.02	-0.03	-0.03	0.00
P10	-0.05	-0.03	-0.03	-0.04	-0.06	-0.04	-0.04	-0.06	-0.38	0.00	0.00	0.00	-0.01	0.00
P90	0.06	0.04	0.04	0.05	0.06	0.04	0.04	0.06	0.25	0.01	0.01	0.01	0.01	0.00
Max	0.38	0.39	0.35	0.18	0.15	0.14	0.13	0.25	0.89	0.02	0.03	0.02	0.03	0.01
Skewness	0.16	2.18	1.83	-3.04	-1.04	0.32	-0.27	-0.72	0.63	-0.87	0.37	-0.87	-0.51	0.41
Excess Kurtosis	7.49	22.21	15.54	26.67	3.62	2.27	3.77	4.93	1.26	4.57	3.35	3.18	3.42	1.16

Table IX
BAB Returns during NBER Recessions, Severe Bear Markets and Market Distress

This table shows calendar-time portfolio returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio and $r_t^{H,i}$ and $r_t^{L,i}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for each security. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low leverage (unlevered ETFs) and high leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low leverage portfolio and shorts the high leverage portfolio: $BAB_t^{ETFs,i} = r_t^{1x,i} - 0.5 * r_t^{2x,i}$ where $r_t^{1x,i}$ is the excess return on the unlevered ETF and $r_t^{2x,i}$ is the excess return of the levered ETF. The ETF BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios and it is rebalanced daily to maintain equal weights. In the "Add ER" column, expense ratios are added back to the fund return. This table includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010. "Excess return" is the delta-hedged return in excess of the Treasury Bills rate (simple excess returns for ETFs). Alpha is the intercept in a regression of monthly excess return. The explanatory variables are the monthly returns from Fama and French (1993) mimicking portfolios, Carhart (1997) momentum factor and a straddle factor. The straddle factor is a portfolio of 1-month zero-beta at-the-money (ATM) S&P 500 index straddles. "Recession" indicates NBER recessions. "Expansion" indicates all other months. "Severe bear market" is defined as a total market return in the past 12-month below -25%. "Rising markets' indicate all other months. "Market return" < -5% and "Market return < -10%" indicate months with contemporaneous market returns below 5% and 10%. Returns and alphas are in monthly percent and 5% statistical significance is indicated in bold.

Panel A: Equity Options		Alpha			t-statistics		
		All	Calls	Puts	All	Calls	Puts
All options	Recession	**0.38**	**0.55**	0.21	2.41	3.65	0.85
	Expansion	**0.38**	**0.24**	**0.52**	9.63	6.18	8.56
	Severe bear market	**0.92**	**-0.08**	**1.93**	7.24	6.51	5.61
	Rising markets	**3.61**	**1.92**	**5.30**	2.73	4.24	2.00
	Market return < -10%	**0.32**	**0.23**	**0.40**	7.24	6.51	5.61
	Market return < -15%	**0.83**	0.96	**0.71**	2.43	1.68	2.11
At-the-money	Recession	**0.37**	0.15	**0.59**	2.13	0.95	2.88
	Expansion	**0.39**	**0.35**	**0.43**	8.27	7.34	7.55
	Severe bear market	**0.06**	**0.27**	**-0.15**	8.02	6.53	7.74
	Rising markets	**1.99**	**1.83**	**2.15**	4.52	11.46	2.62
	Market return < -10%	**0.36**	**0.30**	**0.42**	8.02	6.53	7.74
	Market return < -15%	0.99	0.70	**1.28**	1.78	1.42	1.98
Panel B: Index Options		All	Calls	Puts	All	Calls	Puts
All options	Recession	0.20	**0.47**	-0.07	1.07	2.34	-0.23
	Expansion	**0.34**	**0.12**	**0.55**	6.48	3.24	6.27
	Severe bear market	**1.30**	**-0.22**	**2.82**	4.40	3.49	3.74
	Rising markets	2.64	**0.98**	4.31	1.57	2.05	1.47
	Market return < -10%	**0.24**	**0.12**	**0.36**	4.40	3.49	3.74
	Market return < -15%	**0.97**	1.09	**0.86**	3.04	1.43	2.07
At-the-money	Recession	0.11	-0.07	0.29	0.66	-0.42	1.38
	Expansion	**0.23**	**0.21**	**0.26**	3.64	3.68	3.24
	Severe bear market	**0.06**	**0.35**	**-0.23**	3.39	3.10	3.22
	Rising markets	0.67	0.40	0.95	0.62	0.46	0.62
	Market return < -10%	**0.20**	**0.16**	**0.23**	3.39	3.10	3.22
	Market return < -15%	1.01	0.72	1.30	1.67	1.10	1.78

Figure 1
Embedded Leverage and Excess Delta-Hedged Returns across Maturity and Delta

This figure shows average excess returns of portfolios of options based on maturity and delta. Each calendar month, on the first trading day following expiration Saturday, we assign all options to one of 30 portfolios that are the 5 x 6 interception of 5 portfolios based on the option delta (from deep-in-the-money to deep-out-of-the-money) and 6 portfolio based on the option expiration date (from short-dated to long-dated). All options are value weighted within a given portfolio based on the value of their open interest, and the portfolios are rebalanced every month to maintain value weights. For each delta-maturity bucket we form a call portfolio and a put portfolio and average them. This figure includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and shows average excess returns and means embedded leverage for each of the 30 portfolios. Embedded leverage is defined as $\Omega = |\Delta S/F|$ where Δ is the option delta, F is the option price and S is the spot price. Returns are in monthly percent. "Linear" is a fitted cross sectional regression.

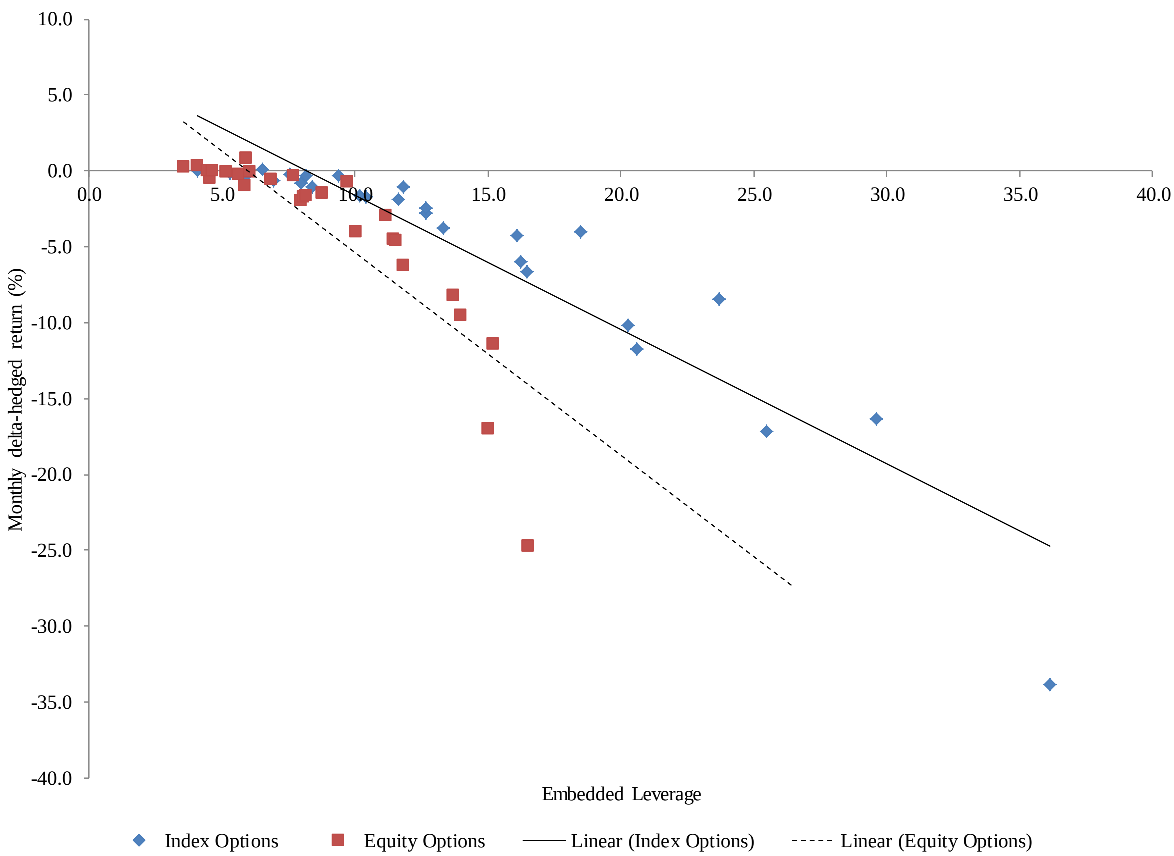

Figure 2
Sharpe ratios of Betting-Against-Beta Portfolios

This figure shows Sharpe ratios of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low embedded leverage portfolio and shorts the high embedded leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio for security i, and $r_{i,t}^{H}$ and $r_{i,t}^{L}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for security i. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low embedded leverage (unlevered ETFs) and high embedded leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low embedded leverage portfolio and shorts the high embedded leverage portfolio: $BAB_t^{ETFs,i} = r_t^{1x,i} - 0.5 * r_t^{2x,i}$ where $r_t^{1x,i}$ is the excess return on the unlevered ETF and $r_t^{2x,i}$ is the excess returns of the levered ETF. The ETFs BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios. The ETF BAB portfolio is rebalanced daily to maintain equal weights. This figure includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010. Sharpe ratios are annualized.

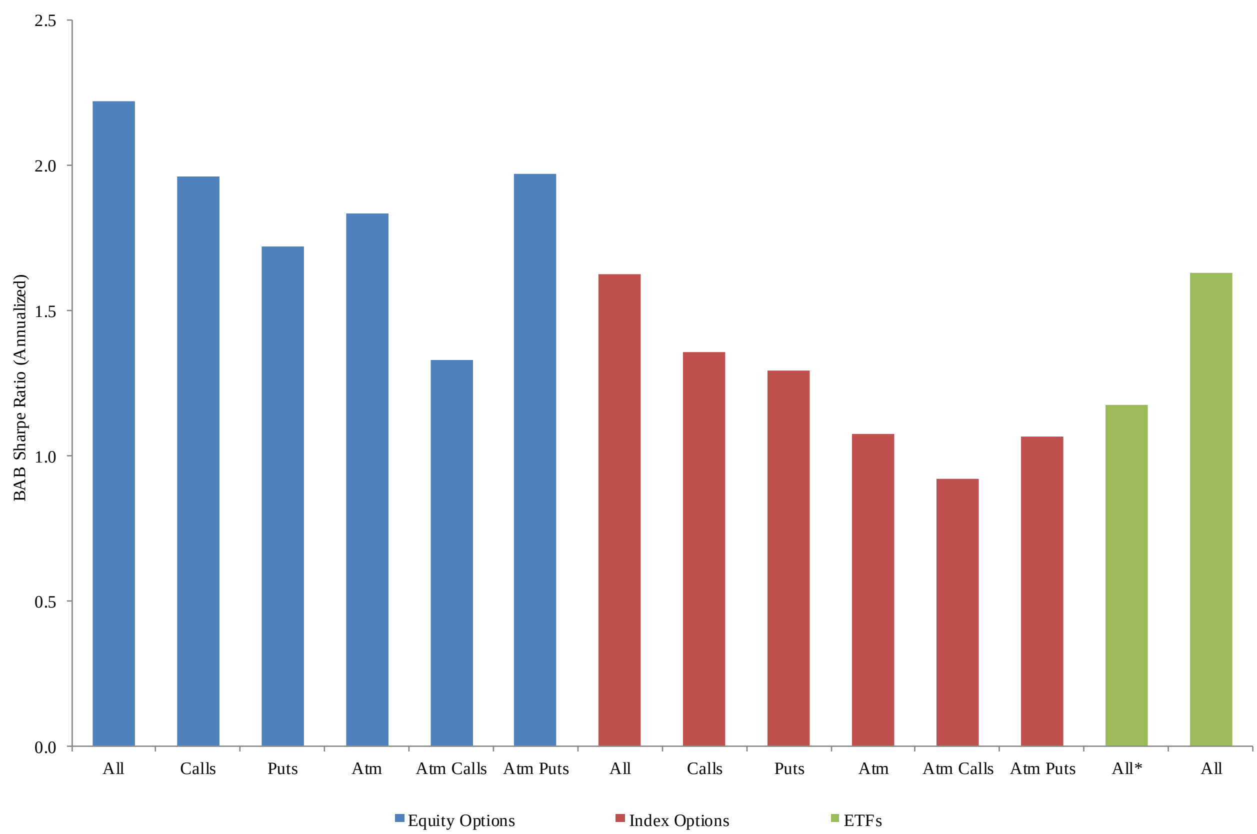

Figure 3
Distribution of Monthly Returns of Betting-Against-Beta portfolios

This figure shows the distribution of monthly returns of Betting-Against-Beta portfolios (BAB). Each calendar month, on the first trading day following expiration Saturday, options are ranked in ascending order on the basis of their embedded leverage. For each security, the ranked options are assigned to one of two portfolios: low embedded leverage (L) and high embedded leverage (H). Options are weighted by their market capitalization and portfolios are rebalanced every calendar month to maintain value weights. Both portfolios are rescaled to have an embedded leverage of 1 at portfolio formation. The BAB portfolio for security i is a self-financing portfolio that is long the low embedded leverage portfolio and shorts the high embedded leverage portfolio: $BAB_t^i = (1/\Omega_{t-1}^{L,i})\, r_t^{L,i} - (1/\Omega_{t-1}^{H,i})\, r_t^{H,i}$ where $\Omega^{H,i}$ and $\Omega^{L,i}$ are the embedded leverage of the value-weighted H and L portfolio for security i, and $r_{i,t}^{H}$ and $r_{i,t}^{L}$ are their respective excess returns. The BAB portfolio is value-weighted portfolio of the individual BAB portfolios with weights equal to the total value of all outstanding options for security i. Similarly, at the end of each trading day, ETFs are assigned to one of two portfolios: low embedded leverage (unlevered ETFs) and high embedded leverage (levered ETFs). The BAB portfolio for index i is a self-financing portfolio that is long the low embedded leverage portfolio and shorts the high embedded leverage portfolio: $BAB_t^{ETFs,i} = r_t^{1x,i} - 0.5 * r_t^{2x,i}$ where $r_t^{1x,i}$ is the excess return on the unlevered ETF and $r_t^{2x,i}$ is the excess returns of the levered ETF. The ETFs BAB portfolio is an equal-weighted portfolio of the individual BAB portfolios. The ETF BAB portfolio is rebalanced daily to maintain equal weights. This figure includes all available options on the domestic OptionMetrics Ivy database between 1996 and 2010 and all the available ETFs in our data between 2006 and 2010 and pools all portfolios in table VI.