

Option Return Predictability, a Machine-Learning Approach

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Abstract

We apply the Least Absolute Shrinkage and Selection Operator (LASSO) to make option return forecasts using 101 signals as candidate predictors. We investigate the entire option universe from January 1996 to December 2016. We hold the options till maturity and buy the options from inception with corresponding positions in the underlying stocks to establish a delta-hedge. Our LASSO results yield delta-hedged trading strategies with annualized Sharpe Ratios above 1 for at-the-money calls and puts with 30 days-to-maturity. The LASSO selected predictors also work well out-of-sample. The LASSO selected predictors are different if we restrict our attention to options of different moneyness or maturities (30-, 60-, or 90-day). Overall, the results emphasize the importance of Capital gains overhang in predicting options returns, as it is one of the most frequently selected characteristics, in addition to lagged one month return of the underlying stock and 12 month momentum of the stock, institutional ownership, Standardized Unexplained Volume, cash-to-asset ratio and book-to-market ratio.

JEL codes: G12, G17

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1. Introduction

The Least Absolute Shrinkage and Selection Operator (LASSO), has been widely used in statistics, biostatistics, medicine and other disciplines (Tibshirani, 1996). Recently a lot of attention has been paid in academia to apply new statistical methods in the machine learning literature, especially LASSO, in applications of Economics and Finance (Mullainathan and Spiess, 2017). Given the large number of signals in the financial market, researchers often do not have prior as to which signals would be the most relevant. Unlike the OLS method, LASSO allows the researchers to rank predictors sequentially according to their "importance". We do not have impose any prior on the choice of predictors or the number of predictors to be selected, as we use cross-validation to choose the penalty parameter, λ , in LASSO.

In the equity space, several researchers have applied the LASSO method to study the return predictability of stocks (Chinco et al., 2017; Freyberger et al., 2017; Feng et al., 2017). To the best of our knowledge, our paper is the first one to apply the LASSO method to evaluate what signals are the most important predictors of options returns.

We study the entire sample of the options universe in the IVY DB OptionMetrics databases from January, 1996 to December, 2006. We choose 101 potential predictors as candidates for LASSO selection. Just to emphasize there is no forward looking bias, all predictors are determined by the day of option holding period. The 101 candidate predictors are listed in Table 30, some of which are known to be very relevant for predicting options returns. In particular, variance premium, which is the difference between historical volatility and the option-implied volatility of the option's underlying stocks, has been found by Goyal and Saretto (2009) to be able to predict option returns. Similarly, Cao and Han (2013) has found that idiosyncratic volatility (Ang et al., 2006) can predict the cross-section of option returns. As standard option pricing theory expect volatility to be an important determinant of option prices (Black and Scholes, 1973), we also include the option-implied volatilities of various terms (30-, 60-, 91-, 122-, and 152-day at-the-money option implied volatility), as well historical volatilities calculated over various terms (10-, 14-, 30-, 60-, 91-, 122-, 152-, 182-, 273-, and 365-day historical volatility).

In addition to option open interest, moneyness and maturity, the other candidate predictors

we choose are the either common accounting ratios, or stock characteristics that have been documented to be able to predict returns, such as momentum (Jegadeesh and Titman, 1993), analyst dispersion (Diether et al., 2002), standardized unexplained volume (Garfinkel and Sokobin, 2006), capital gains overhang (Grinblatt and Han, 2005), institutional ownership (Lehavy and Sloan, 2008), stock liquidity measure (Amihud, 2002), cash-to-asset ratio (Palazzo, 2012), lagged one-month stock returns (Jegadeesh, 1990), and other characteristics.

In terms of results, Table 9 summarizes the factors selected for each class of sample and reports the in-sample Sharpe ratios obtained by longing the top 10% options and shorting the bottom 10% options predicted by LASSO estimated returns. The LASSO results can give rise to a highly profitable trading strategy with a monthly Sharpe ratio of 0.65 (2.25 annualized) for calls and 0.39 (1.35 annualized) for puts with 30 days-to maturity, and results are varied for other options.

In terms of the most frequently appeared predictors, capital gains overhang of the underlying stock is the most frequently selected characteristic that helps predicting option returns, followed by reversal (lagged one month return of the underlying stock), institutional ownership, momentum (return from minus 12 month to minus 2 month of the underlying), cash-to-asset ratio, book-to-market ratio, and standardized unexplained volume (Garfinkel and Sokobin, 2006). Although momentum, size and book-to-market effects are already well-known for predicting stock returns, we offer the new insight that capital gains overhang (Grinblatt and Han, 2005), is generally more important than the few aforementioned stock-return-predictors in determining options returns, and that institutional ownership, standardized unexplained volume, and cash-to-asset ratio are as important. Per Grinblatt and Han (2005), capital gains overhang is closely related to the behavioral bias which many investors have in their reluctance to those stocks on which they have a capital loss, and thus, stocks with large past price run-ups and stocks on which most investors experienced capital gains have higher expected returns than those that have experienced large declines and capital losses.

The LASSO selected predictors also work well out-of-sample. For example, as indicated in Table 14, the return of previous month, capital gains overhang, institutional ownership, price-to-book ratio, after-tax return on invested capital, after-tax return on average common equity, and historical volatility of the underlying stock for the past 365-days, the variance

premium (60 day HV minus 30 day IV), which is the difference between 60-day historical volatility and the 30-day option-implied volatility of the option’s underlying stock, and forward P/E to long-term growth (PEG) ratio of the underlying stock are the top 10 most important predictors according to the in-sample LASSO analysis for 30 days to maturity put options with moneyness between 0.975 and 1.025. Now if we were to follow the in-sample selected characteristics and investing in a long-short strategy, Table 15 indicates we can result in a monthly return of 5.76% (95% annualized), with a t -stat over 10, for this particular option category, out-of-sample.

Cao et al. (2017) has studied a number of known characteristics that could predict stock returns to test whether the same could predict option returns, including idiosyncratic volatility, past stock returns, profitability, cash holding, new share issuance, and dispersion of analyst forecast. We, however, incorporate machine learning to rank the predictors out of a much larger set of candidates.

The rest of the paper is organized as follows, in Section 2 we discuss the data and methodology, in Section 3 we discuss the LASSO results, in Section 4 we discuss the results of sorting the delta-hedged returns based on LASSO selected predictors for in-sample and out-of-sample data, Section 5 concludes.

2. Data and Methodology

2.1. Methodology: LASSO and cross-validation

We use LASSO method as proposed by Tibshirani (1996) to find a model that best predicts option returns from available information. The LASSO method is equivalent to solving the following optimization problem:

$$\hat{\beta} = \arg \min_{\beta} \left\{ \sum_{i=1}^N \left(y_i - \sum_j \beta_j x_{ij} \right)^2 + \lambda \sum_j \beta_j^2 \right\} \quad (1)$$

The first part of the equation is the sum of residual squares, which is what we minimize in OLS estimation. The second part,

$$\lambda \sum_j \beta_j^2 \quad (2)$$

is a penalty function. λ is called the penalty parameter that is determined in advance. If there is extremely large or small estimation of the coefficients, the penalty function will increase the value of the objective function. As a result, the use of the penalty function avoids extreme estimation in OLS, as explained by [Chinco et al. \(2017\)](#). The larger λ is, the less extreme the estimation will be.

In the meantime, we use 10-fold cross-validation to find the best model by selecting among 101 variables. A 10-fold cross-validation process divides all data into ten roughly equal-sized groups. For each of the ten groups, the model is fit on the other nine groups of data. Then, the sum of squared residuals is calculated for the group based on the estimated coefficients on the other nine groups. The final prediction error of the model is decided by the sum of the ten sums of squared residuals for each of the group.

The LASSO and 10-fold cross-validation method adds or removes one variable step by step. The method assesses the prediction error of adding each of the variable that are not selected and the prediction error of removing each of the variable already selected. The process that produces the lowest prediction error is decided to be the next step, and the prediction error after adding(removing) the variable is the prediction error of the step. The process continues until all of the candidate variables have been ranked into steps based on the prediction errors. Finally, by comparing the prediction error of each step, the step with the lowest prediction error is the optimal step to stop at. The resulted model is the optimal model selected by the LASSO and cross-validation method.

2.2. Data

To study the behavior of option returns, we obtained data on options from January 1996 to December 2016 from Option Metrics Ivy DB. The database provides pricing information and

option greeks and other characteristic variables of all American options, including historical realized volatilities and implied volatilities of the options. The data on corresponding stocks are obtained from CRSP database. The accounting data are from COMPUSTAT. The analyst coverage and forecast data are from I/B/E/S. Most of the financial ratios are from the WRDS Applications Database by Wharton Research Data Services.

We follow [Goyal and Saretto \(2009\)](#) to filter data so as to minimize the impact of recording errors. We exclude observations that violates no-arbitrage conditions. We also follow their rule to eliminate observations that have larger bid prices than ask prices, zero bid prices, or bid-ask spreads that are lower than the minimum tick size (\$0.05 for option trading below \$3 and \$0.10 in any other cases). To avoid illiquid options, we exclude all observations that has zero open interest or volume, which is suggested by [Diether et al. \(2002\)](#). In addition, since the options data from Option Metrics are of American type, we follow the method of [Cao et al. \(2017\)](#) and eliminate an option if the corresponding stock paid a dividend during the rest of the days before maturity or if the option is not standard type. This filter guarantees that the remaining options are of European type. Following [Cao et al. \(2017\)](#), we also eliminate options with a mid-point of bid and ask prices that is lower than \$0.125 to avoid biases on microstructure.

We construct options portfolios following [Goyal and Saretto \(2009\)](#). We use the information of options that start to trade on the third Monday of each month and have one month to maturity. For each month and for each stock, we select one call and one put options that are closest to at-the-money. To obtain robust results, we obtain LASSO results on samples with moneyness between 0.975 and 1.025 and on samples with moneyness between 0.75 and 1.25. For the options with moneyness between 0.975 and 1.025, we run LASSO on options with different days to maturity, including 30-day, 60-day, and 90-day maturities.

To test the robustness of the LASSO results, for each month, we hold roughly 25% of the total observations available as out of sample observations by randomly selecting about 50 stocks each month. The rest of the observations are the training sample. We obtain LASSO results on the training sample and predict the option returns for both training and out of

sample observations based on the model estimated. Then we sort all of the observations, training observations, and out of sample observations separately on the predicted returns and the factors selected in the LASSO prediction model. If there are more than ten variables in the model, we only sort option returns on the ten variables that are in top ten steps of the LASSO selection process.

Option returns are measured by delta-hedged returns. Delta-hedged return is measured by the value change of a portfolio that longs a call (put) option and shorts (longs) delta shares of the underlying stock. Following [Goyal and Saretto \(2009\)](#), we calculate the beginning price of the portfolio as the midpoint of bid and ask prices of the option minus delta times the price of the underlying stock on the initiation date of the strategy. To calculate the delta-hedged option return till maturity, the ending price of the portfolio is the call option price at maturity minus delta times the underlying stock price at the expiration date of the option. Delta-hedged option gain is calculated as ending price less beginning price scaled by the underlying stock price at the strategy initiation date.

To find a model that predicts option returns as accurate as possible, we included 101 variables in the LASSO estimation process. The 101 variables include characteristics of options, financial ratios of the firm, analyst forecasts and institutional ownership. The reference source of the variables and formula of financial ratios are presented in the Appendix on page [30](#).

3. LASSO Results

Table [1](#) to Table [8](#) presents the LASSO results of each type of options. Table [9](#) summarizes the factors selected for each class of options and reports the in-sample Sharpe ratios obtained by longing the top 10% options and shorting the bottom 10% options predicted by LASSO estimated returns.

The Sharpe Ratios presented in Table [9](#) are not annualized but correspond to the number of days of the maturity of the option. We do so because of the well-known econometric

shortcoming (Lo, 2002) of simply multiplying the 30-day Sharpe ratios by $\sqrt{12}$ or the 60-Sharpe ratios by $\sqrt{6}$.

Table 9 also shows that among all of the 101 factors included in the estimation, capital gains overhang has a rather significant role in predicting option returns. From Table 9, the LASSO results for seven out of the eight classes of samples selected capital gains overhang as an important factor to reduce the error in predicting option returns. According to the finding of Grinblatt and Han (2005), the aggregate capital gains have significantly positive correlation with future stock returns. But the sign of the coefficients for capital gains overhang are negative for 30 days to maturity call options with moneyness ranging from 0.975 to 1.025 and 30 days to maturity call options with moneyness ranging from 0.75 to 1.25. The results imply that capital gains overhang are negatively correlated with the returns of at-the-money call options with one month to maturity despite its positive correlation with future stock returns.

In addition to capital gains overhang, lagged one month stock return and institutional ownership of the stock also have strong power in reducing the error of option return predictions, as both of the variables are selected six times out of eight times for different types of options. The regression coefficients for lagged one month stock return are all negative, which supports the finding from Jegadeesh (1990) that future stock returns are strongly negatively correlated with the monthly stock returns at the end of the previous month. Five of the coefficients for institutional ownership in predicting 30-day and 60-day to maturity options are positive, and the coefficient for institutional ownership in predicting 90-day to maturity options are negative. The results are highly consistent with the conclusion of Lehavy and Sloan (2008) that recognition of investors is positively correlated with short-term stock returns and negatively correlated with longer-term stock returns.

Among the factors that are selected five times out of a total of eight times selections, the coefficients on standardized unexplained volume, which is calculated as the regression error of regressing trading volume on the absolute value of returns, are all negative (Garfinkel, 2009). The results suggest that standardized unexplained volume, as a proxy for divergence of investors' opinions, is negatively related to option returns.

According to the LASSO results, the cumulative return on the stock over the 11 months ending at the beginning of the previous month is also an important factor that are selected five times out of eight rounds of selection. Most of the coefficients suggest a positive correlation between the factor and the option returns, which are consistent with the finding of [Jegadeesh and Titman \(1993\)](#) that suggest a positive correlation between momentum and stock returns. The only coefficient of the 11-month cumulative return that is negative is for the model estimation of put option returns with moneyness between 0.75 and 1.25 and with 30 days to maturity. But since the moneyness for this sample of options are not strictly at-the-money and the cumulative return is included at the 47th step, the LASSO results for all of the eight rounds selections are still consistent with the traditional conclusions.

From Tables 1 to 8, we can also find that book to market ratio and cash-to-assets ratio appear to be positively correlated with call option returns and negatively correlated with put option returns. The diluted price-to-earnings ratio that includes extraordinary items are negatively related to one month to maturity call and put options returns, and positively related to three months to maturity put option returns. Labor expense as percentage of sales is also negatively related to one month to maturity call and put options returns, and positively related to three months to maturity put option returns. Also, all of the five coefficients for price-to-book ratio suggest a negative relationship between the ratio and option returns. Especially, price-to-book ratio is strong in predict put option returns, since price-to-book ratio is selected by LASSO in the estimations for all of the four samples of put options.

4. Portfolios Sorting Results

To see the magnitude of the predictive power of LASSO results on both in-sample observations and out-of-sample observations, for each class of options, we separately sort all observations, in-sample observations, and out-of-sample observations on the predicted option returns and up to 10 selected factors. If the selected factors are more than 10, we only sort on the factors in the top 10 steps of LASSO selection. We sort all options into 10 deciles and report the returns of each decile and the returns of longing the top 10% portfolio and

shorting the bottom 10% portfolio. Portfolio sorting on the dummy variable of Standard & Poor 500 is omitted, since it is not possible to sort observations into 10 deciles based on the dummy variable. The results of sorting portfolios are reported in Table 10 to Table 29.

4.1. Call Options with Moneyness from 0.975 to 1.025 and with 30 Days to Maturity

According to Table 11, the portfolio sorting results of in-sample data shows that sorting portfolios according to the predicted returns from the LASSO model produces a strongly significant positive return by longing the top 10% portfolio and shorting bottom 10% portfolio. The long-short monthly return of 0.883% is significant at 1% level with a t statistic of 3.29. Portfolio sorting by capital gains overhang and price-to-book ratio also produce strongly significant 10-1 portfolio returns at 1% level, and the returns are 0.61% and 0.617%. Also, sorting by the diluted price-to-earnings ratio including extraordinary items produces significant 10-1 portfolio returns of 0.426% at 5% level. The table also shows that the magnitude of the t-value and the return for the 10-1 portfolio sorted by predicted return is larger than any of the other three significant t-values and returns. The results imply that LASSO method can find a more accurate model in predicting option returns compared to predicting the option returns by each single variable.

Table 10 shows that, for all of the observations, sorting portfolios based on LASSO predicted return still produces a strongly significant 10-1 portfolio monthly return of 0.761% with a t-value of 3.35. Capital gains overhang and price-to-book ratio still predict significant returns of 0.51% and 0.757% at 1% level. The predictive power of lagged one month stock return increases and appears to be significantly and negatively related to option returns, which is consistent with the finding of Jegadeesh (1990). The long-short return produced by lagged one month stock return is 0.565% at 5% significance level. The diluted price-to-earnings ratio including extraordinary items appears to be less accurate in predicting option returns, and the predictive power is not significant for the sample of all observations. By comparison, the magnitude of the long-short return predicted by LASSO model is still larger than the returns predicted by any other single variable.

Table 12 presents the portfolio sorting results for out-of-sample observations. The 10-1 portfolio return obtained according to the LASSO model is still significant with a t statistic of 2.09. The result implies that the estimated model by LASSO has robust predictive power even in out-of-sample data, and produces a long-short portfolio return of 0.622%. The 10-1 portfolio return sorted by lagged one month stock return, price-to-book ratio, and cumulative return over 11 months are also significant in out-of-sample data with t values of -2.43, -3.32, and -1.8 respectively, which imply negative correlations between the three variables and the delta-hedged option returns. The significant monthly long-short portfolio returns produced by these three factors are 0.864%, 0.885%, and 0.556% respectively.

Sorting portfolios by price-to-earnings ratio in all of the three samples produce strongly significant 10-1 portfolio returns. Lagged one month stock return also shows significantly negative relationship with option returns in out-of-sample observations and all observations. The predictive power of the two variables are consistent with the results in Table 9, implying the strong relationship between the two variables and option returns.

4.2. Put Options with Moneyness from 0.975 to 1.025 and with 30 Days to Maturity

The portfolio sorting results of in-sample data is presented in Table 14. The 10-1 portfolio return by LASSO predicted return is a large monthly return of 5.572%, which is strongly significant with a t-value of 12.14. Notably, the portfolio return for each of the ten decile increases monotonically as the predicted return increases. The results show outstanding accuracy of the LASSO model in predicting option returns. The returns of 10-1 portfolio sorted by lagged one month return, price-to-book ratio, price-to-sales ratio, price-to-cash flow ratio, and forward P/E to long-term growth ratio also produce large and strongly significant monthly returns with t-values of -9.88, -4.23, -3.25, -2.78, and -2.12. The resulted absolute value of long-short returns are 5.004%, 1.519%, 1.223%, 1.088%, and 0.799% respectively. Comparing the t-values and returns, we find that LASSO predicted option return produce more significant and larger long-short portfolio return than any of the other factors.

Table 13 shows the results of portfolio sorting on all observations for the type of options. The LASSO model predicted option return produces a 5.619% monthly return with t statistic of 13.20, which is larger and more significant than the corresponding 10-1 portfolio return for in-sample observations. The portfolio returns for each of the 10 decile are still monotonically increasing with predicted option returns. In the meantime, lagged one month stock return, price-to-book ratio, price-to-sales ratio, price-to-cash flow ratio, and forward P/E to long-term growth ratio still produce huge and strongly significant 10-1 portfolio returns at 1% level. Especially, sorting by lagged one month return produces a 5.347% monthly 10-1 portfolio return with a t statistic of -11.79, which is remarkably large and significant. In addition, capital gains overhang and volatility premium of 60-day historical volatility less 30-day implied volatility appear to have stronger predictive power in the sample of all observation, and their corresponding 10-1 portfolio returns become significant. The absolute value of the t statistic for the long-short return on portfolios sorted by capital gains overhang increases from 0.91 to 2.12, which is significant at 5% level, and the corresponding return increases from 0.396% to 0.776%. The absolute value of the t statistic for the long-short return on portfolios sorted by the volatility premium increases from 0.76 to 2.15, which is significant at 5% level, and the corresponding return increases from 0.212% to 0.473%.

The out-of-sample data sorting results is presented in Table 15. The LASSO model still provides accurate prediction of option returns in out-of-sample data. The 10 decile portfolio returns increase monotonically with predicted returns. The 10-1 portfolio produces a strongly significant and large monthly return of 5.76% with a t-value of 10.16, which is strongly significant at 1% level. Lagged one month stock return still has the strongest power in predicting option returns compared to other single factors. The long-short portfolio return produced by lagged one month stock return is 5.270% with a t-value of -9.01, which is significant at 1% level. The 10-1 portfolio returns produced by capital gains overhang, price-to-book ratio, and price-to-cash flow ratio also remain their predictive power and produces significant 10-1 portfolio returns of 1.105%, 1.881%, and 1.290% respectively, with t statistics of -2.56, -3.98, and -3.09, which are all significant at 1% level.

Comparing the sorting results of put options to the results of call options with similar moneyness and maturity, we find that put options are relatively easier to predict than call options. This is not only because the 10-1 portfolio returns of put options are larger and more significant than that of call options, but also because that the 10 decile portfolio returns of put options monotonically increases with the predicted option return by LASSO model.

4.3. Call Options with Moneyness from 0.975 to 1.025 and with 60 Days to Maturity

Table 17 shows the results of portfolio sorting for in-sample observations for 60 days to maturity at-the-money call options. Our LASSO model still provides strong predictions and results in a significant 10-1 portfolio return till maturity of 1.788% with a t-value of 4.03, which is significant at 1% level. Single variables including pre-tax return on total earning assets, gross debt to earnings before interest ratio, after tax interest coverage, operating cash flow to current liabilities, market value of equity, and free cash flow-to-operating cash flow ratio have significant power in predicting option returns. The resulted absolute values of long-short portfolio returns for these variables are 0.797%, 1.076%, 0.936%, 0.711%, 0.810%, and 0.781% respectively, with t-values of -1.84, 2.38, -2.00, -1.65, -1.86, and -1.66 respectively. Comparing the t-values in the table, we find that though none of the single factors can produce a long-short option return that is significant at 1% level, the model selected by LASSO method that combines these variables can provides accurate predictions and produce a larger long-short portfolio return that is strongly significant at 1% level.

The sorting results for all observations are presented in Table 16. The 10-1 portfolio return sorted by LASSO predicted return is still significant and has the magnitude of 1.706%, which shows the robust predictive power of the estimated model by LASSO method. Gross debt to earnings before interest ratio, after tax interest coverage, market value of equity, and free cash flow-to-operating cash flow ratio can still predict significant 10-1 portfolio returns, which are delta-hedged returns till option maturity of 1.049%, 0.763%, 0.722%, and 0.786% respectively. The returns are significant at 1%, 10%, 10%, and 10% level respectively. Sorting results of out-of-sample data is omitted, because the number of out-of-sample observations is

no more than 1,500, which is not sufficient for obtaining reliable portfolio sorting results.

Comparing the significant factors for call options with 60-day maturity to the significant factors for call options with 30-day maturity, we find that liquidity related ratios play more important role in predicting longer maturity option returns, such as after-tax interest coverage and operating cash flow to current liabilities. Returns of call options with shorter maturity are more related to unrealized gains and values, which can be reflected by capital gains overhang and price-to-book ratios.

4.4. Put Options with Moneyness from 0.975 to 1.025 and with 60 Days to Maturity

Sorting results of in-sample data is presented in Table 19. The sorted 10-1 portfolio return according to predicted return is still significant, and the return for put options is larger and more significant than that of the call options with similar days to maturity and moneyness range. Portfolio sorting on predicted option returns results in a delta-hedged return till maturity of 5.438%, which has a t-value of 7.23 and is significant at 1% level. Lagged one month return and price-to-book ratios still have strong predictive power in 60-day to maturity put option returns, resulting in returns till maturity for the 10-1 portfolios of 5.516% and 3.508% respectively. The t-values of the returns are -7.23 and -5.22, which show the strong negative correlations between the two variables and the option returns, resulting in long-short portfolio returns that are significant at 1% level. In addition, after-tax return on invested capital, which measures a firm's profitability, also appears to be significant in predicting returns for the type of put options. The resulted absolute value of long-short return is 1.095%, with a negative t-value of -1.70, which is significant at 10% level.

The sorting results on all observations in Table 18 are similar to the sorting results on in-sample observations. The 10-1 portfolio return produced by predicted return is 5.542% and has a t-value of 9.07, which is strongly significant at 1% level. Lagged one month return and price-to-book ratio still produce large and significant 10-1 portfolio returns till maturity, the absolute values of which are 5.259% and 3.152% respectively. The t-values of

the returns are -8.68 and -6.02, which are significant at 1% level. After-tax return on invested capital becomes insignificant in predicting options returns for all observations, but after-tax return on average common equity, which also indicates profitability, becomes significant in predicting option returns. The long-short portfolio return produced by after-tax return on average common equity has an absolute value of 0.802% with a t-value of -1.71, which is significant at 10% level. Portfolio sorting results on out-of-sample observations are omitted because of lack of observations.

Comparing the results to the sorting results of put options with 30-day maturity, we find that lagged one month stock return and price-to-book ratio persistently have significant power in predicting put option returns even when days to maturity becomes longer.

4.5. Call Options with Moneyness from 0.975 to 1.025 and with 90 Days to Maturity

Table 21 presents the portfolio sorting results on the in-sample call options with 90 days to maturity. The 10-1 portfolio sorted according to predicted return is a delta-hedged option return till maturity of 1.888% with t-value of 2.30, which is significant at 5% level. There are only two factors selected to predict the option returns, which are cumulative return over 11 months ending at the end of the previous month and the volatility premium of 365-day historical volatility less 30-day implied volatility for at-the-money options. Both of the factors have significant effects and are positively related to the option returns. Sorting portfolios by cumulative return over 11 months results in a long-short return of 2.661%, which has a t-value of 2.68 and is significant at 1% level. Sorting portfolios by the volatility premium results in a long-short return of 1.771%, which has a t-value of 2.34 and is significant at 5% level. By comparison, we find that though the long-short portfolio return resulted by predicted return is less than the long-short return resulted by cumulative return over 11 months, the LASSO selected model provides more accurate predictions in option returns than both of the other two factors. From the portfolio returns of the 10 decile portfolios, we see that portfolio returns sorted by predicted return monotonically increases with predicted returns in the top 70% portfolios. The portfolio returns sorted by cumulative return over 11

months are much more volatile than that are sorted by LASSO estimation.

The sorting results for all observations presented in Table 20 shows similar results to portfolio sorting on in-sample data. The long-short portfolio return based on predicted return is significant at 5% level with a t-value of 2.28, and the return is 1.84%. Cumulative return over 11 months and the volatility premium are all significant and are positively related to the option returns. The resulted long-short portfolio returns are 2.55% and 1.65% respectively, with t-values of 2.64 and 2.11, which are significant at 1% and 5% levels. Portfolio sorting results on out-of-sample data are omitted because of lack of observations.

In addition to the positive effect of cumulative return over 11 months that have been proven by Jegadeesh and Titman (1993), the positive effects of the volatility premium are consistent with the findings from Goyal and Saretto (2009). Their paper shows that at-the-money call option returns are significantly positively related to volatility dispersion, which is measured by the volatility premium of annual historical volatility less the implied volatility of at-the-money options measured over one month.

4.6. Put Options with Moneyness from 0.975 to 1.025 and with 90 Days to Maturity

Table 23 shows that the in-sample observations sorted based on predicted option returns still produce a large positive long-short return of 6.24%, with a t-value of 4.29, which is significant at 1% level. In the meantime, sales per dollar of total stockholders' equity, lagged one month return, and price-to-sales ratio also produce significant 10-1 portfolio returns. The absolute values of option returns till maturity are 3.770%, 6.209%, and 7.244%, and the t-values are 2.18, -2.61, and -2.47, which are significant at 5%, 1%, and 5% level respectively.

The sorting results for all observations in Table 22 are similar to the results for in-sample data. LASSO predicted option return still generates a significant long-short option return till maturity of 6.172%, with a t-value of 4.33, which is significant at 1% level. Factors that produce significant long-short portfolio returns are still sales per dollar total stockholders'

equity, lagged one month return, and price-to-sales ratio, which generate long-short option returns of 3.523%, 6.1%, and 6.773% respectively. The t-values are 2.09, -2.67, and -2.38, which show the significance of the returns at 5%, 1%, and 5% level respectively. Portfolio sorting results on out-of-sample data are omitted because of lack of observations.

The results further prove the strong power of lagged one month return in predicting option returns. In the meantime, sales per dollar total stockholders' equity and price-to-sales ratio are all indicators of profitability. It is consistent with the findings from the sorting results on 60-day maturity put options that indicator of profitability becomes important factors for put options with longer days to maturity.

4.7. Call Options with Moneyness from 0.75 to 1.25 and with 30 Days to Maturity

To test the robustness of the predictive power of LASSO method, we also obtain LASSO results and portfolio results on call options with 30 days to maturity and a wider range of moneyness, which is from 0.75 to 1.25. The results for in-sample observations in Table 25 still show that sorting portfolios by predicted return generates a significant and positive long-short option return of 0.892% at a significance level of 1% as the t-value is 4.83. In addition, the sorting results show that volatility premium suggested by [Goyal and Saretto \(2009\)](#) is significantly and positively related to option returns. The long-short portfolio return produced by the volatility premium of 365-day historical volatility less 30-day implied at-the-money volatility is 0.761% with a t-value of 5.62, which is significant at 1% level. Significant negative relationships with the option returns are found on idiosyncratic volatility, operating cash flow to current liabilities, free cash flow-to-operating cash flow ratio, and net profit margin. The absolute values of long-short portfolio returns produced by these factors are 0.292%, 0.428%, 0.615%, and 0.333% respectively, and the corresponding t statistics are -1.86, -2.81, -4.08, and -2.04, which signal the significance of the returns at 10%, 1%, 1%, and 5% level. The negative relationship between idiosyncratic volatility and option returns are consistent with the finding of [Ang et al. \(2006\)](#) that higher idiosyncratic volatility relative to the [Fama and French \(1993\)](#) model is related to low stock returns.

In Table 24, sorting portfolios on predicted return still produces a significant and positive long-short return of 0.891% with a t-value of 5.11. Idiosyncratic volatility, operating cash flow to current liabilities, the volatility premium of 365-day historical volatility less 30-day implied at-the-money volatility, free cash flow-to-operating cash flow ratio, and net profit margin still have significant power in predicting option returns, and produce absolute values of long-short portfolio returns of 0.288%, 0.445%, 0.705%, 0.657%, and 0.360% respectively. The corresponding t-values are -2.01, -2.94, 5.35, -4.45, and -2.43, which show the significance of the returns at 5%, 1%, 1%, 1%, and 5% levels. In addition, lagged one month return appears to have significantly negative effects on option returns and produces a long-short portfolio return of 0.404%, which is significant at 10% level. But the magnitude and the significance of the effect is largely less than its effects on options that are closer to at-the-money, which could be found in Table 10.

From the portfolio sorting results on out-of-sample data presented in Table 26, we find the model obtained by LASSO method still produces a significant and positive long-short return of 0.911% with a t-value of 3.24. In the out-of-sample data, only lagged one month return, the volatility premium, and free cash flow-to-operating cash flow ratio significantly predicts option returns. Only the long-short portfolio return produced by the volatility premium is significant at 1% level with a magnitude of 0.625%. The long-short portfolio return produced by lagged one month stock return and free cash flow-to-operating cash flow ratio are only significant at 10% level with magnitudes of 0.624% and 0.468% respectively. Remarkably, though most of the factors ranked in the top 10 steps cannot significantly predicts option return alone, the model selected by LASSO that combines these variables produces a more significant and larger long-short return than all of the long-short returns predicted by these ten variables alone.

4.8. Put Options with Moneyness from 0.75 to 1.25 and with 30 Days to Maturity

From Table 28, we find that the LASSO model predicts put option returns more accurately than predicts call option returns with similar moneyness and maturity, which is the same

conclusion that we draw from the portfolio sorting results on call and put options with 30 days to maturity but much closer to at-the-money. Portfolio returns of the 10 deciles increases monotonically with predicted return. The long-short portfolio produces a strongly significant and large return of 5.134% with t-value of 14.44, which is remarkably large. Lagged one month return, moneyness of the option, price-to-book ratio, volatility premium, forward P/E to long-term growth ratio, and standardized unexplained volume also have strongly significant power in predicting option returns. The resulted absolute values of the long-short returns for these factors are 4.612%, 0.875%, 1.569%, 0.561%, 0.770%, and 0.666% respectively, and the t-values are -11.95, 2.97, -5.28, 2.58, -2.64, and -4.22, which signal that the long-short portfolio returns for all these variables are significant at 1% level. The LASSO predicted return still has the strongest and largest predictive power among these factors.

The sorting results on all observations in Table 27 supports that LASSO predicted return has the strongest power in predicting option returns among all of the ten factors ranked at top 10 steps for LASSO factor selection. Sorting portfolios on predicted return results in a strongly significant and positive monthly return of 5.316% with a t-value of 14.98. Similar to the results for in-sample data, lagged one month return, moneyness of the option, price-to-book ratio, volatility premium, forward P/E to long-term growth ratio, and standardized unexplained volume can still significantly predict option returns. The absolute values of the long-short portfolio returns are 4.667%, 0.849%, 1.541%, 0.521%, 0.781%, and 0.591%. The t-values show that the long-short return produced by the volatility premium is significant at 5% level, and the returns produced by the other five single factors are all significant at 1% level.

The portfolio sorting results on out-of-sample data presented in Table 29 provides a strong evidence of the predictive power of the LASSO selected model. Even in out-of-sample data, the LASSO predicted return still have the most significant power among the listed ten factors in predicting option returns. The magnitude of the long-short return is 5.424%, with a t-value of 10.15. In out-of-sample data, moneyness and standardized unexplained volume has limited power in predicting returns, and the resulted long-short return is insignificant.

Lagged one month return, price-to-book ratio, and forward P/E to long-term growth ratio still can generate significant long-short returns of 5.598%, 1.356%, and 1.172%, which are all significant at 1% level. In addition, capital gains overhang appears to have significant power in predicting option returns in out-of-sample data and results in a long-short portfolio return of 1.038% with a t -value of 2.47, which is significant at 5% level.

The results further support the finding that put option returns are easier to predict than call options. The strong predictive power of lagged one month return and price-to-book ratio are also further proven in the portfolio sorting results for at-the-money put options with 30-day to maturity and a wider range of moneyness. Comparing the LASSO predicted long-short return to the long-short returns predicted by each single variables, LASSO method is proven to have significant power in combining variables to provide more accurate predictions in returns.

5. Conclusion

In this paper, we apply the Least Absolute Shrinkage and Selection Operator (LASSO) to make option return forecasts using 101 signals as candidate predictors. We investigate the entire option universe from January 1996 to December 2016. We hold the options till maturity and buy the options from inception with corresponding positions in the underlying stocks to establish a delta-hedge. The LASSO results can give rise to a highly profitable trading strategy with a monthly Sharpe ratio of 0.65 (2.25 annualized) for calls and 0.39 (1.35 annualized) for puts with 30 days-to maturity, and a more varied results for other options.

The LASSO selected predictors also work well out-of-sample. For example, as indicated in Table 15, investing in a long-short strategy following LASSO selected predicted returns can result in a monthly return of 5.76% (95% annualized), with a t -stat over 10. The return of previous month, capital gains overhang, institutional ownership, volatility premium (the difference between implied volatility of historical volatility), idiosyncratic volatility, historical volatility and price-to-book ratio are usually the selected predictors according to LASSO. The LASSO selected predictors are different if we restrict our attention to options of different

moneyiness or maturities (30-, 60-, or 90-day).

If we take Table 9 as one of the main takeaways of this paper, then we can see that capital gains overhang of the underlying stock is the most frequently selected characteristic that helps predicting option returns, followed by lagged one month return of the underlying stock and 12 month momentum of the stock, institutional ownership, cash-to-asset ratio and book-to-market ratio. It is true that momentums, reversal and book-to-market effects are well-known in the literature predicting the returns of the underlying stocks, but what might be a novel insight is that capital gains overhang ([Grinblatt and Han, 2005](#)) of the underlying stock (which highlights the importance of disposition effects in options trading), institutional ownership and standardized unexplained volume of the underlying stock ([Garfinkel and Sokobin, 2006](#)) are so important in determining options returns.

In addition, one can see that, as expected, various measures of uncertainty, including idiosyncratic volatility, and the difference between realized and implied volatility also rank high in the variable selection.

Table 1: LASSO Results: Call options, Moneyiness 0.975-1.025, Days to Maturity 30

Step	Variable	Factor	Coefficient
0	Intercept	Intercept	-0.0032520
1	ret_1	Lagged one month return	-0.0194020
2	cgobeg	Capital gains overhang	-0.0321070
3	ior	Institutional ownership	0.0048860
4	ptb	Price-to-book	-0.0001310
5	pe.inc	Price-to-earnings, incl. EI (diluted)	-0.0000085
6	hv182	Option's calculated realized volatility of the last 182 days	-0.0017210
7	ps	Price-to-sales ratio	-0.0000767
8	inv_turn	Inventory turnover	-0.0000057
9	ivol	Idiosyncratic volatility	-0.0153190
10	ret_122	Cumulative return on the stock over the 11 months ending at the beginning of the previous month	0.0007650
11	staff_sale	Labor expense as % of sales	-0.0024160
12	pcf	Price-to-cash flow	-0.0000033
13	VPh91i60	Volatility premium: 91-day historical volatility less 60-day implied volatility	-0.0001790
14	suv	Standardized Unexplained Volume	-0.0000341
15	lnbm	Logarithm of the book to market ratio	0.0001100
16	chr	Cash-to-assets ratio	0.0003530

Table 2: LASSO Results: Put Options, Moneyiness 0.975-1.025, Days to Maturity 30

Step	Variable	Factor	Coefficient
0	Intercept	Intercept	-0.006567000
1	ret_1	Lagged one month return	-0.194979000
2	cgobeg	Capital gains overhang	0.105304000
3	ptb	Price-to-book	-0.001142000
4	ps	Price-to-sales ratio	-0.000648000
5	sp500	Dummy of standard & poor 500	-0.003721000
6	ior	Institutional ownership	0.004741000
7	pcf	Price-to-cash flow	-0.000036487
8	hv365	Option's calculated realized volatility of the last 365 days	-0.019458000
9	VPh60i30	Volatility premium: 60-day historical volatility less 30-day implied volatility	0.007310000
10	PEG_ltgforward	Forward P/E to long-term growth (PEG) ratio	-0.000138000
11	roa	Return on assets	0.012039000
12	hv10	Option's calculated realized volatility of the last 10 days	0.005687000
13	pe_inc	Price-to-earnings, incl. EI (diluted)	-0.000008997
14	rect_turn	Receivables turnover	0.000003032
15	lnbm	Logarithm of the book to market ratio	-0.003996000
16	ret_122	Cumulative return on the stock over the 11 months ending at the beginning of the previous month	0.000344000
17	lt_ppent	Total liabilities to total tangible assets	0.000106000
18	suv	Standardized Unexplained Volume	-0.000207000
19	iv152	At-the-money option's implied volatility over 152 days	0.019464000
20	pretret_noa	Pre-tax return on net operating assets	0.000082779
21	PEG_1yrforward	Forward P/E to 1-year growth (PEG) ratio	0.000064686
22	sale_equity	Sales per dollar total stockholders' equity	0.000013553
23	evm	Enterprise value multiple	0.000006588
24	roce	Return on capital employed	0.002490000
25	short_debt	Short term debt as % of total debt	0.000760000
26	money	Moneyiness	0.006804000
27	hv122	Option's calculated realized volatility of the last 122 days	-0.007364000
28	aftret_invcapx	After-tax return on invested capital	-0.001413000
29	debt_at	Total debt as % of total assets	0.000319000
30	at_turn	Asset turnover	-0.000047206
31	BE	Shareholder's equity	0.000000002
32	VPh152i30	Volatility premium: 152-day historical volatility less 30-day implied volatility	0.000134000

Table 3: LASSO Results: Call Options, Moneyiness 0.975-1.025, Days to Maturity 60

Step	Variable	Factor	Coefficient
0	Intercept	Intercept	0.0210220
1	pretret_earnat	Pre-tax return on total earning assets	-0.0086180
2	debt_ebitda	Gross debt to ebitda	0.0003100
3	intcov_ratio	Interest coverage ratio	-0.0000067
4	intcov	After tax interest coverage	-0.0000206
5	ocf_lct	Operating cash flow to current liabilities	-0.0031930
6	lnbm	Logarithm of the book to market ratio	0.0010960
7	lnme	Logarithm of the market value of equity	-0.0009130
8	cgobeg	Capital gains overhang	0.0211360
9	VPh60i30	Volatility premium: 60-day historical volatility less 30-day implied volatility	0.0039180
10	fcf_ocf	Free cash flow/Operating cash flow	-0.0004670
11	pay_turn	Payables turnover	-0.0001830
12	suv	Standardized Unexplained Volume	-0.0005010
13	ior	Institutional ownership	0.0026700
14	inv_act	Inventory as % of current assets	-0.0050260
15	iv60	At-the-money option's implied volatility over 60 days	-0.0067870
16	chr	Cash-to-assets ratio	0.0069830
17	pe_exi	Price-to-earnings, excl. EI (diluted)	-0.0000059
18	ib	Income before extraordinary Items	-0.0000001
19	aftret_eq	After-tax return on average common equity	0.0000656
20	pretret_noa	Pre-tax return on net operating assets	-0.0001460
21	gpm	Gross profit margin	-0.0013820
22	sale_equity	Sales per dollar total stockholders' equity	0.0000457
23	npm	Net profit margin	-0.0010180
24	cash_lt	Cash balance to total liabilities	0.0007450
25	debt_at	Total debt as % of total assets	-0.0018640
26	staff_sale	Labor expense as % of sales	-0.0010380
27	int_debt	Interest as % of average long-term debt	-0.0000022

Table 4: LASSO Results: Put Options, Moneyiness 0.975-1.025, Days to Maturity 60

Step	Variable	Factor	Coefficient
0	Intercept	Intercept	-0.0039890
1	ret_1	Lagged one month return	-0.1203690
2	cgobeg	Capital gains overhang	0.0890830
3	ptb	Price-to-book	-0.0002890
4	aftret_invcapx	After-tax return on invested capital	-0.0032010
5	hv365	After-tax return on average common equity	-0.0024160
6	aftret_eq	Option's calculated realized volatility of the last 365 days	0.0001430

Table 5: LASSO Results: Call Options, Moneyiness 0.975-1.025, Days to Maturity 90

Step	Variable	Factor	Coefficient
0	Intercept	Intercept	-0.0061940
1	ret_122	Cumulative return on the stock over the 11 months ending at the beginning of the previous month	0.0058320
2	VPh365i30	Volatility premium: 365-day historical volatility less 30-day implied volatility	0.0014960

Table 6: LASSO Selection Results: Put Options, Moneyiness 0.975-1.025, Days to Maturity 90

Step	Variable	Factor	Coefficient
0	Intercept	Intercept	-0.0094660
1	ret_122	Cumulative return on the stock over the 11 months ending at the beginning of the previous month	0.0360900
2	sale_equity	Sales per dollar total stockholders' equity	0.0005790
3	ret_1	Lagged one month return	-0.1212890
4	de_ratio	Debt-to-shareholders' equity	0.0018560
5	sp500	Dummy of standard & poor 500	-0.0118490
6	cgobeg	Capital gains overhang	0.1828840
7	inv_t_act	Inventory as % of current assets	0.0127090
8	pe_op_basic	Price/Operating earnings (Basic, Excl. EI)	0.0000925
9	pe_exi	Price-to-earnings, excl. EI (diluted)	0.0000981
10	ps	Price-to-sales ratio	-0.0044520
11	pe_inc	Price-to-earnings, incl. EI (diluted)	0.0000402
12	evm	Enterprise value multiple	0.0013480
13	rect_act	Receivables as % of current assets	-0.0106730
14	hv10	Option's calculated realized volatility of the last 10 days	0.0164020
15	ptb	Price-to-book	-0.0016390
16	adv_sale	Advertising as % of sales	0.1135620
17	pcf	Price-to-cash flow	0.0000514
18	dpr	Dividend payout ratio	-0.0015080
19	ivol	Idiosyncratic volatility	0.0731860
20	lnamihud	Amihud stock liquidity measure	0.0003620
21	chr	Cash-to-assets ratio	-0.0197510
22	ior	Institutional ownership	-0.0078330
23	aftret_invcapx	After-tax return on invested capital	-0.0087480
24	CAPEI	Shillers cyclically adjusted P/E ratio	-0.0000013
25	cash_conversion	Cash conversion cycle	0.0000240
26	staff_sale	Labor expense as % of sales	0.0035440
27	cfm	Cash flow margin	0.0047370
28	VPh365i30	Volatility premium: 365-day historical volatility less 30-day implied volatility	0.0003580

Table 7: "LASSO Selection Results: Call Options, Moneyness 0.75-1.25, Days to Maturity 30"

Step	Variable	Factor	Coefficient
0	Intercept	Intercept	0.02357200
1	ret_1	Lagged one month return	-0.02240600
2	cgobeg	Capital gains overhang	-0.03331000
3	hv122	Option's calculated realized volatility of the last 122 days	-0.01634300
4	ivol	Idiosyncratic volatility	-0.19499400
5	ocf_lct	Operating cash flow to current liabilities	-0.00076600
6	ior	Institutional ownership	0.00311100
7	VPh365i30	Volatility premium: 365-day historical volatility less 30-day implied volatility	0.00223900
8	fcf_ocf	Free cash flow/Operating cash flow	-0.00020900
9	npm	Net profit margin	-0.00665700
10	sp500	Dummy of standard & poor 500	-0.00071000
11	lnamihud	Amihud stock liquidity measure	0.00089800
12	debt_ebitda	Gross debt to ebitda	0.00005601
13	hv10	Option's calculated realized volatility of the last 10 days	0.00237700
14	disp1	Analyst Forecast Dispersion in Prior Month	-0.00048100
15	lnbm	Logarithm of the book to market ratio	0.00070800
16	cash_conversion	Cash conversion cycle	0.00000690
17	accrual	Accruals/Average assets	-0.00634600
18	suv	Standardized Unexplained Volume	-0.00024600
19	staff_sale	Labor expense as % of sales	-0.00338100
20	roe	Return on equity	-0.00083100
21	aftret_eq	After-tax return on average common equity	-0.00011500
22	VPh152i30	Volatility premium: 152-day historical volatility less 30-day implied volatility	0.00298100
23	hv14	Option's calculated realized volatility of the last 14 days	0.00601500
24	pay_turn	Payables turnover	-0.00003134
25	debt_capital	Debt-to-capital	0.00296700
26	PEG_1yrforward	Forward P/E to 1-year growth (PEG) ratio	0.00005635
27	VPh91i30	Volatility premium: 91-day historical volatility less 30-day implied volatility	0.00413500
28	adv_sale	Advertising as % of sales	0.00721900
29	open_interest	Open interest	0.00000007
30	rect_act	Receivables as % of current assets	0.00179900
31	pe_op_basic	Price/Operating earnings (Basic, Excl. EI)	0.00000406
32	de_ratio	Debt-to-shareholders' equity	-0.00001173
33	chr	Cash-to-assets ratio	0.00292000
34	pe_inc	Price-to-earnings, incl. EI (diluted)	-0.00000169
35	hv91	At-the-money option's implied volatility over 91 days	-0.00699000
36	iv152	At-the-money option's implied volatility over 152 days	0.01057100

37	dpr	Dividend payout ratio	0.00001416
38	Gprof	Gross profit to total assets	0.00035400
39	roa	Return on assets	0.00189900

Table 8: LASSO Selection Results: Put Options, Moneyiness 0.75-1.25, Days to Maturity 30

Step	Variable	Factor	Coefficient
0	Intercept	Intercept	-0.0848110
1	ret_1	Lagged one month return	-0.2030540
2	cgobeg	Capital gains overhang	0.0978000
3	money	Moneyiness	0.0622920
4	ptb	Price-to-book	-0.0015110
5	VPh60i30	Volatility premium: 60-day historical volatility less 30-day implied volatility	0.0027680
6	ior	Institutional ownership	0.0099680
7	sp500	Dummy of standard & poor 500	-0.0056230
8	PEG_ltgforward	Forward P/E to long-term growth (PEG) ratio	-0.0003900
9	hv365	Option's calculated realized volatility of the last 365 days	-0.0287630
10	suv	Standardized Unexplained Volume	-0.0008560
11	debt_at	Total debt as % of total assets	0.0169200
12	accrual	Accruals/Average assets	-0.0276790
13	dpr	Dividend payout ratio	-0.0002350
14	pcf	Price-to-cash flow	-0.0000307
15	ivol	Idiosyncratic volatility	-0.3232390
16	hv10	Option's calculated realized volatility of the last 10 days	0.0124320
17	at_turn	Asset turnover	-0.0064570
18	profit_lct	Profit before D&A to current liabilities	0.0007730
19	pe_inc	Price-to-earnings, incl. EI (diluted)	-0.0000120
20	lnbm	Logarithm of the book to market ratio	-0.0071140
21	cash_ratio	Cash ratio	0.0017610
22	staff_sale	Labor expense as % of sales	-0.0089940
23	PEG_1yrforward	Forward P/E to 1-year growth (PEG) ratio	0.0001510
24	ps	Price-to-sales ratio	-0.0014400
25	iv152	At-the-money option's implied volatility over 152 days	0.1373640
26	VPh152i30	Volatility premium: 152-day historical volatility less 30-day implied volatility	0.0050590
27	hv122	At-the-money option's implied volatility over 122 days	-0.0650880
28	debt_ebitda	Gross debt to ebitda	-0.0005320
29	pretret_noa	Pre-tax return on net operating assets	-0.0002970
30	lnme	Logarithm of the market value of equity	0.0034490
31	VPh91i30	Volatility premium: 91-day historical volatility less 30-day implied volatility	0.0064010
32	disp1	Analyst Forecast Dispersion in Prior Month	-0.0001650
33	aftret_invcapx	After-tax return on invested capital	-0.0122350

34	rd_sale	R&D as % of sales	-0.0073430
35	int_totdebt	Interest as % of average total debt	0.0003270
36	ib	Income before extraordinary Items	-0.0000005
37	hv182	Option's calculated realized volatility of the last 182 days	-0.0211780
38	adv_sale	Advertising as % of sales	0.0096430
39	aftret_equity	After-tax return on total stockholders equity	0.0001630
40	dltt_be	Long-term debt to book equity	-0.0003620
41	pe_op_basic	Price/Operating earnings (Basic, Excl. EI)	-0.0000028
42	chr	Cash-to-assets ratio	-0.005807
43	CAPEI	Shillers cyclically adjusted P/E ratio	0.0000001
44	intcov	After tax interest coverage	0.0000376
45	int_debt	Interest as % of average long-term debt	-0.0000312
46	hv14	Option's calculated realized volatility of the last 14 days	0.0029550
47	ret_122	Cumulative return on the stock over the 11 months ending at the beginning of the previous month	-0.000729
48	cash_lt	Cash balance to total liabilities	0.0015310
49	pay_turn	Payables turnover	0.0000354
50	lnamihud	Amihud stock liquidity measure	0.001373
51	VPh152i60	Volatility premium: 152-day historical volatility less 60-day implied volatility	0.0211070
52	roa	Return on assets	0.0107010
53	sale_invcap	Sales per dollar invested capital	0.0017300
54	sale_equity	Sales per dollar total stockholders' equity	0.0000265
55	intcov_ratio	Interest coverage ratio	-0.0000244
56	gpm	Gross profit margin	-0.0066010
57	ptpm	Pre-tax profit margin	-0.0074180
58	rect_act	Receivables as % of current assets	-0.0012370
59	hv60	Option's calculated realized volatility of the last 60 days	0.0136390
60	cash_debt	Operating cash flow to total debt	0.0017050
61	evm	Enterprise value multiple	0.0000601
62	pe_exi	Price-to-earnings, excl. EI (diluted)	0.0000069
63	iv30	At-the-money option's implied volatility over 30 days	-0.0298800
64	opmbd	Operating profit margin before depreciation	0.0077120
65	Gprof	Gross profit to total assets	0.0035810
66	fcf_ocf	Free cash flow/Operating cash flow	-0.0000114
67	VPh365i30	Volatility premium: 365-day historical volatility less 30-day implied volatility	0.0018300
68	rect_turn	Receivables turnover	-0.0000004
69	roe	Return on equity	0.0004170
70	curr_ratio	Current ratio	-0.0001450
71	short_debt	Short term debt as % of total debt	-0.0005060
72	equity_invcap	Common equity to invested apital	0.0011250
73	de_ratio	Debt-to-shareholders' equity	-0.0000020
74	hv152	Option's calculated realized volatility of the last 152 days	0.0064770

Table 9: Summary of the Number of Times Each Factor is Selected

This table presents the number of times that each of the factors are selected in LASSO model. The in-sample Sharpe ratios of longing top 10% portfolios and shorting bottom 10% portfolios based on LASSO predicted returns are also reported. Portfolio returns are equally-weighted. The Sharpe Ratios (SR) are standardized to monthly SR. For selected variables, the descriptions are given in the first column.

Never selected variables: Operating profit margin after depreciation, Capitalization ratio, Current liabilities as % of total liabilities, Long-term debt as % of total liabilities, Debt-to-assets, Quick ratio, Option's calculated realized volatility of the last 30 days, Option's calculated realized volatility of the last 273 days, At-the-money option's implied volatility over 91 days, At-the-money option's implied volatility over 122 days, Volatility premium: 91-day historical volatility less 60-day implied volatility.

Call or Put			Call	Put	Call	Put	Call	Put	Call	Put
Moneyness			0.975-1.025	0.975-1.025	0.975-1.025	0.975-1.025	0.975-1.025	0.975-1.025	0.75-1.25	0.75-1.25
Days to Maturity			30	30	60	60	90	90	30	30
Sharpe Ratio			0.65	0.39	0.31	0.15	0.15	0.07	0.59	0.22
Factors	Variable Name	Times Selected	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital gains overhang	cgobeg	7	cgobeg	cgobeg	cgobeg	cgobeg		cgobeg	cgobeg	cgobeg
Institutional ownership	IOR	6	IOR	IOR	IOR			IOR	IOR	IOR
Lagged one month return	ret_1	6	ret_1	ret_1		ret_1		ret_1	ret_1	ret_1
Standardized Unexplained Volume	suv	5	suv	suv	suv				suv	suv
Cumulative return on the stock over the 11 months ending at the beginning of the previous month	ret_122	5	ret_122	ret_122			ret_122	ret_122		ret_122
Cash-to-assets ratio	chr	5	chr		chr			chr	chr	chr
Logarithm of the book to market ratio	lnbm	5	lnbm	lnbm	lnbm				lnbm	lnbm

Price-to-earnings, incl. EI (diluted)	pe_inc	5	pe_inc	pe_inc		pe_inc	pe_inc	pe_inc
Labor expense as % of sales	staff_sale	5	staff_sale		staff_sale	staff_sale	staff_sale	staff_sale
Price-to-book	ptb	5	ptb	ptb	ptb	ptb		ptb
Idiosyncratic volatility	ivol	4	ivol			ivol	ivol	ivol
Price-to-sales ratio	ps	4	ps	ps		ps		ps
Price-to-cash flow	pcf	4	pcf	pcf		pcf		pcf
After-tax return on invested capital	aftret_invcapx	4		aftret_invcapx	aftret_invcapx	aftret_invcapx		aftret_invcapx
Sales per dollar total stock- holders' equity	sale_equity	4		sale_equity	sale_equity	sale_equity		sale_equity
Dummy of standard & poor 500	sp500	4		sp500		sp500	sp500	sp500
Option's calculated realized volatility of the last 10 days	hv10	4		hv10		hv10	hv10	hv10
Volatility premium: 365-day historical volatility less 30- day implied volatility	VPh365i30	4			VPh365i30	VPh365i30	VPh365i30	VPh365i30
Amihud stock liquidity mea- sure	lnamihud	3				lnamihud	lnamihud	lnamihud
Enterprise value multiple	evm	3		evm		evm		evm
Price/Operating earnings (Basic, Excl. EI)	pe_op_basic	3				pe_op_basic	pe_op_basic	pe_op_basic
Price-to-earnings, excl. EI (diluted)	pe_exi	3		pe_exi		pe_exi		pe_exi
Dividend payout ratio	dpr	3				dpr	dpr	dpr
Return on assets	roa	3		roa			roa	roa
After-tax return on average common equity	aftret_eq	3			aftret_eq	aftret_eq	aftret_eq	

Pre-tax return on net operating assets	pretret_noa	3	pretret_noa	pretret_noa	pretret_noa
Gross debt to ebitda	debt_ebitda	3		debt_ebitda	debt_ebitda
Free cash flow/Operating cash flow	fcf_ocf	3		fcf_ocf	fcf_ocf
Debt-to-shareholders' equity	de_ratio	3		de_ratio	de_ratio
Total debt as % of total assets	debt_at	3	debt_at	debt_at	debt_at
Receivables as % of current assets	rect_act	3		rect_act	rect_act
Payables turnover	pay_turn	3		pay_turn	pay_turn
Advertising as % of sales	adv_sale	3		adv_sale	adv_sale
Forward P/E to 1-year growth (PEG) ratio	PEG_1yrforward	3	PEG_1yrforward	PEG_1yrforward	PEG_1yrforward
Option's calculated realized volatility of the last 122 days	hv122	3	hv122		hv122
Option's calculated realized volatility of the last 365 days	hv365	3	hv365	hv365	hv365
At-the-money option's implied volatility over 152 days	iv152	3	iv152		iv152
Volatility premium: 152-day historical volatility less 30-day implied volatility	VPh152i30	3	VPh152i30		VPh152i30
Volatility premium: 91-day historical volatility less 30-day implied volatility	VPh91i30	3	VPh91i30		VPh91i30
Volatility premium: 60-day historical volatility less 30-day implied volatility	VPh60i30	3	VPh60i30	VPh60i30	VPh60i30

Analyst Forecast Dispersion in Prior Month	disp1	2			disp1	disp1
Moneyiness	money	2	money			money
Logarithm of the market value of equity	lnme	2		lnme		lnme
Income before extraordinary Items	ib	2		ib		ib
Shillers cyclically adjusted P/E ratio	CAPEI	2			CAPEI	CAPEI
Net profit margin	npm	2		npm	npm	
Gross profit margin	gpm	2		gpm		gpm
Return on equity	roe	2			roe	roe
Gross profit to total assets	GProf	2			Gprof	Gprof
Interest as % of average long-term debt	int_debt	2		int_debt		int_debt
Cash balance to total liabilities	cash_lt	2		cash_lt		cash_lt
Inventory as % of current assets	inv_t_act	2		inv_t_act	inv_t_act	
Short term debt as % of total debt	short_debt	2	short_debt			short_debt
Operating cash flow to current liabilities	ocf_lct	2		ocf_lct	ocf_lct	
After tax interest coverage	intcov	2		intcov		intcov
Interest coverage ratio	intcov_ratio	2		intcov_ratio		intcov_ratio
Cash conversion cycle	cash_conversion	2			cash_conversion	cash_conversion
Asset turnover	at_turn	2	at_turn			at_turn
Receivables turnover	rect_turn	2	rect_turn			rect_turn
Accruals/Average assets	accrual	2			accrual	accrual

Forward P/E to long-term growth (PEG) ratio	PEG.ltgforward	2	PEG.ltgforward	PEG.ltgforward
Option's calculated realized volatility of the last 14 days	hv14	2	hv14	hv14
Option's calculated realized volatility of the last 182 days	hv182	2	hv182	hv182
Open interest	open_interest	1	open_interest	open_interest
Shareholder's equity	BE	1	BE	BE
Operating profit margin before depreciation	opmbd	1	opmbd	opmbd
Pre-tax profit margin	ptpm	1	ptpm	ptpm
Cash flow margin	cfm	1	cfm	cfm
Return on capital employed	roce	1	roce	roce
After-tax return on total stockholders equity	aftret_equity	1	aftret_equity	aftret_equity
Pre-tax return on total earning assets	pretret_earnat	1	pretret_earnat	pretret_earnat
Common equity to invested capital	equity_invcap	1	equity_invcap	equity_invcap
Interest as % of average total debt	int_totdebt	1	int_totdebt	int_totdebt
Profit before D&A to current liabilities	profit_lct	1	profit_lct	profit_lct
Operating cash flow to total debt	cash_debt	1	cash_debt	cash_debt
Total liabilities to total tangible assets	lt_ppent	1	lt_ppent	lt_ppent
Long-term debt to book equity	dltt_be	1	dltt_be	dltt_be

Debt-to-capital	debt_capital	1			debt_capital
Cash ratio	cash_ratio	1			cash_ratio
Current ratio	curr_ratio	1			curr_ratio
Inventory turnover	inv_turn	1	inv_turn		
Sales per dollar invested capital	sale_invcap	1			sale_invcap
R&D as % of sales	rd_sale	1			rd_sale
Option's calculated realized volatility of the last 60 days	hv60	1			hv60
Option's calculated realized volatility of the last 91 days	hv91	1			hv91
Option's calculated realized volatility of the last 152 days	hv152	1			hv152
At-the-money option's implied volatility over 30 days	iv30	1			iv30
At-the-money option's implied volatility over 60 days	iv60	1		iv60	
Volatility premium: 152-day historical volatility less 60-day implied volatility	VPh152i60	1			VPh152i60

Tables 10 to 29 report equally-weighted portfolio returns for each of the 10 decile portfolios sorted on each of the factors. The returns for P10-P1 are the equally-weighted returns of longing the top 10% portfolio and shorting the bottom 10% portfolio. The numbers reported in parentheses are t-values for the long-short portfolio returns. Symbols *, **, and *** signal that the long-short return is significantly different from 0 at significance levels of 10%, 5%, and 1% respectively.

Table 10: Portfolio Sorting: Call Options, Moneyness 0.975-1.025, Days to Maturity 30, All Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-0.507%	-0.432%	-0.511%	-0.474%	-0.462%	-0.386%	-0.112%	-0.341%	-0.147%	0.254%	0.761%
1	ret_1	0.333%	-0.142%	-0.280%	-0.549%	-0.462%	-0.381%	-0.470%	-0.421%	-0.365%	-0.232%	(3.35)***
2	cgobeg	-0.100%	-0.101%	-0.011%	-0.312%	-0.298%	-0.451%	-0.290%	-0.471%	-0.482%	-0.609%	-0.565% (-1.99)**
3	ior	-0.392%	-0.271%	-0.428%	-0.276%	-0.383%	-0.298%	-0.261%	-0.124%	-0.351%	-0.339%	-0.510% (-2.36)***
4	ptb	0.178%	-0.291%	-0.401%	-0.249%	-0.224%	-0.413%	-0.254%	-0.371%	-0.468%	-0.579%	0.053% (0.27)
5	pe_inc	0.020%	-0.280%	-0.282%	-0.205%	-0.349%	-0.357%	-0.597%	-0.485%	-0.319%	-0.267%	-0.757% (-4.07)***
6	hv182	-0.262%	-0.368%	-0.355%	-0.260%	-0.357%	-0.375%	-0.384%	-0.390%	-0.165%	-0.232%	-0.287% (-1.43)
7	ps	-0.112%	-0.122%	-0.166%	-0.292%	-0.209%	-0.422%	-0.570%	-0.353%	-0.388%	-0.379%	0.031% (0.15)
8	inv_turn	-0.357%	-0.382%	-0.330%	-0.394%	-0.179%	-0.208%	-0.337%	-0.314%	-0.186%	-0.423%	-0.267% (-1.43)
9	ivol	-0.117%	-0.246%	-0.391%	-0.278%	-0.098%	-0.378%	-0.429%	-0.497%	-0.293%	-0.365%	-0.066% (-0.40)
10	ret_122	-0.124%	-0.156%	-0.338%	-0.384%	-0.161%	-0.529%	-0.493%	-0.256%	-0.376%	-0.223%	-0.248% (-1.46)
												-0.099% (-0.44)

Table 11: Portfolio Sorting: Call Options, Moneyness 0.975-1.025, Days to Maturity 30, In-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-0.607%	-0.344%	-0.402%	-0.444%	-0.509%	-0.412%	-0.056%	-0.002%	-0.084%	0.272%	0.883%
1	ret_1	0.276%	-0.083%	-0.231%	-0.500%	-0.460%	-0.347%	-0.424%	-0.335%	-0.370%	-0.143%	(3.29)*** -0.436% (-1.39)
2	cgobeg	-0.012%	-0.092%	0.053%	-0.199%	-0.249%	-0.457%	-0.178%	-0.454%	-0.434%	-0.574%	-0.610% (-2.58)***
3	ior	-0.528%	-0.144%	-0.457%	-0.201%	-0.273%	-0.202%	-0.289%	-0.127%	-0.237%	-0.207%	0.280% (1.22)
4	ptb	-0.004%	-0.121%	-0.433%	0.019%	-0.097%	-0.394%	-0.349%	-0.313%	-0.404%	-0.601%	-0.617% (-3.04)***
5	pe_inc	-0.016%	-0.095%	-0.280%	-0.241%	-0.100%	-0.212%	-0.632%	-0.458%	-0.231%	-0.450%	-0.426% (-1.99)**
6	hv182	-0.242%	-0.345%	-0.376%	-0.269%	-0.137%	-0.506%	-0.340%	-0.117%	-0.081%	-0.179%	0.017% (0.07)
7	ps	-0.160%	-0.227%	-0.048%	-0.067%	-0.217%	-0.252%	-0.504%	-0.359%	-0.354%	-0.501%	-0.311% (-1.51)
8	inv_turn	-0.458%	-0.382%	-0.280%	-0.138%	-0.128%	-0.223%	-0.239%	-0.139%	-0.222%	-0.380%	0.022% (0.12)
9	ivol	-0.138%	-0.167%	-0.315%	-0.239%	-0.066%	-0.444%	-0.327%	-0.396%	-0.211%	-0.255%	-0.117% (-0.66)
10	ret_122	-0.294%	0.064%	-0.223%	-0.472%	-0.093%	-0.474%	-0.502%	-0.270%	-0.249%	-0.187%	0.090% (0.37)

Table 12: Portfolio Sorting: Call Options, Moneyness 0.975-1.025, Days to Maturity 30, Out-of-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-0.239%	-0.643%	-0.336%	-0.534%	-0.455%	-0.263%	-0.407%	-0.298%	-0.150%	0.383%	0.622%
1	ret_1	0.589%	-0.401%	-0.261%	-0.398%	-0.520%	-0.379%	-0.586%	-0.237%	-0.455%	-0.275%	(2.09)** -0.864%
2	cgobeg	-0.053%	0.079%	-0.014%	-0.252%	-0.530%	-0.412%	-0.330%	-0.525%	-0.351%	-0.466%	(-2.43)** -0.413%
3	ior	-0.200%	-0.418%	-0.313%	-0.449%	-0.460%	-0.204%	-0.329%	-0.368%	-0.224%	-0.030%	(-1.42) 0.170%
4	ptb	0.459%	-0.346%	-0.374%	-0.471%	-0.383%	-0.183%	-0.423%	-0.327%	-0.403%	-0.426%	(0.71) -0.885%
5	pe_inc	-0.127%	-0.036%	-0.222%	-0.383%	-0.448%	-0.496%	-0.269%	-0.343%	-0.598%	-0.023%	(-3.32)** 0.104%
6	hv182	-0.236%	-0.310%	-0.380%	-0.334%	-0.217%	-0.285%	-0.256%	-0.385%	-0.552%	0.014%	(0.47) 0.250%
7	ps	0.123%	-0.140%	-0.307%	-0.483%	-0.403%	-0.253%	-0.430%	-0.286%	-0.500%	-0.170%	(0.82) -0.293%
8	inv_turn	-0.284%	-0.333%	-0.495%	-0.419%	-0.498%	-0.091%	-0.233%	-0.283%	0.023%	-0.306%	(-1.02) -0.023%
9	ivol	-0.145%	-0.272%	-0.422%	-0.211%	-0.015%	-0.337%	-0.290%	-0.579%	-0.184%	-0.484%	(-0.12) -0.339%
10	ret_122	0.223%	-0.381%	-0.319%	-0.166%	-0.495%	-0.620%	-0.440%	-0.214%	-0.218%	-0.332%	(-1.37) -0.556%
												(-1.80)*

Table 13: Portfolio Sorting: Put Options, Moneyness 0.975-1.025, Days to Maturity 30, All Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-2.849%	-1.690%	-1.478%	-1.057%	-0.775%	-0.536%	-0.247%	0.184%	1.126%	2.770%	5.619%
												(13.20)***
1	ret_1	2.669%	0.845%	0.388%	-0.406%	-0.271%	-0.688%	-1.305%	-1.367%	-1.564%	-2.678%	-5.347%
												(-11.79)***
2	cgobeg	-0.075%	-0.501%	-0.074%	-0.353%	-0.487%	-0.730%	-0.455%	-0.540%	-0.392%	-0.851%	-0.776%
												(-2.12)**
3	ptb	0.627%	-0.132%	-0.361%	-0.287%	-0.468%	-0.383%	-0.738%	-0.444%	-1.234%	-1.141%	-1.767%
												(-5.41)***
4	ps	0.268%	-0.380%	0.012%	-0.384%	-0.341%	-0.628%	-0.669%	-0.703%	-0.803%	-0.692%	-0.960%
												(-2.65)***
5	ior	-0.576%	-0.524%	-0.479%	-0.320%	-0.711%	-0.306%	-0.399%	-0.350%	-0.438%	-0.389%	0.187%
												(0.54)
6	pcf	0.290%	0.057%	-0.115%	-0.472%	-0.567%	-0.749%	-0.360%	-0.833%	-0.663%	-1.206%	-1.496%
												(-4.90)***
7	hv365	-0.287%	-0.519%	-0.592%	-0.436%	-0.518%	-0.140%	-0.726%	-0.778%	-0.468%	0.013%	0.300%
												(0.71)
8	VPh60i30	-0.707%	-0.763%	-0.660%	-0.571%	-0.344%	-0.658%	-0.306%	-0.294%	-0.022%	-0.234%	0.473%
												(2.15)**
9	PEG_ltgforward	-0.144%	0.001%	0.130%	-0.036%	-0.565%	-0.973%	-0.659%	-0.707%	-0.757%	-0.770%	-0.626%
												(-2.01)**

Table 14: Portfolio Sorting: Put Options, Moneyness 0.975-1.025, Days to Maturity 30, In-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-2.680%	-1.704%	-1.333%	-1.199%	-0.653%	-0.580%	-0.240%	0.324%	1.351%	2.856%	5.572%
												(12.14)***
1	ret_1	2.488%	1.075%	0.527%	-0.372%	-0.062%	-0.626%	-1.306%	-1.311%	-1.697%	-2.526%	-5.004%
												(-9.88)***
2	cgobeg	-0.248%	-0.207%	-0.218%	-0.189%	-0.399%	-0.534%	-0.426%	-0.552%	-0.317%	-0.674%	-0.396%
												(-0.91)
3	ptb	0.497%	0.193%	-0.250%	-0.019%	-0.167%	-0.661%	-0.750%	-0.473%	-1.294%	-1.041%	-1.519%
												(-4.23)***
4	ps	0.573%	-0.382%	0.170%	-0.114%	-0.458%	-0.516%	-0.655%	-0.661%	-0.950%	-0.783%	-1.223%
												(-3.25)***
5	ior	-0.523%	-0.521%	-0.644%	-0.069%	-0.514%	-0.001%	-0.460%	-0.317%	-0.481%	-0.242%	0.310%
												(0.75)
6	pcf	0.030%	0.371%	0.065%	-0.567%	-0.752%	-0.510%	-0.298%	-0.863%	-0.596%	-1.076%	-1.088%
												(-2.78)***
7	hv365	-0.304%	-0.495%	-0.617%	-0.577%	-0.317%	0.060%	-0.474%	-0.722%	-0.173%	-0.126%	0.212%
												(0.47)
8	VPh60i30	-0.359%	-0.586%	-0.639%	-0.736%	-0.035%	-0.622%	-0.206%	-0.422%	-0.079%	-0.171%	0.212%
												(0.76)
9	PEG_ltgforward	-0.073%	0.153%	0.172%	0.254%	-0.370%	-0.581%	-0.888%	-0.884%	-0.863%	-0.881%	-0.799%
												(-2.12)**

Table 15: Portfolio Sorting: Put Options, Moneyness 0.975-1.025, Days to Maturity 30, Out-of-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-2.669%	-1.408%	-1.197%	-0.715%	-0.708%	-0.525%	0.055%	0.067%	1.013%	3.091%	5.760%
1	ret_1	2.896%	0.578%	0.559%	-0.124%	-0.534%	-0.283%	-1.027%	-1.272%	-1.421%	-2.374%	(10.16)*** -5.270%
2	cgobeg	0.305%	-0.250%	0.174%	-0.381%	-0.382%	-0.486%	-0.473%	-0.376%	-0.341%	-0.800%	(-9.01)*** -1.105%
3	ptb	0.846%	-0.192%	-0.020%	-0.575%	-0.229%	-0.030%	-0.557%	-0.344%	-0.826%	-1.035%	(-2.56)*** -1.881%
4	ps	0.423%	-0.113%	0.030%	-0.499%	-0.622%	-0.387%	-0.179%	-0.602%	-0.515%	-0.344%	(-3.98)*** -0.767%
5	ior	-0.257%	-0.552%	-0.410%	0.063%	-0.853%	-0.199%	-0.567%	-0.302%	-0.156%	0.088%	(-1.42) 0.345%
6	pcf	0.647%	-0.040%	-0.142%	-0.276%	-0.575%	-0.284%	-0.492%	-0.811%	-0.465%	-0.643%	(0.69) -1.290%
7	hv365	-0.305%	-0.208%	-0.696%	0.089%	-0.472%	0.072%	-0.560%	-0.619%	-0.761%	0.464%	(-3.09)*** 0.769%
8	VPh60i30	-0.429%	-0.356%	-0.542%	-0.310%	-0.573%	-0.586%	-0.358%	0.025%	0.285%	-0.153%	(1.30) 0.275%
9	PEG_ltgforward	-0.043%	0.169%	0.045%	0.032%	-0.078%	-0.908%	-0.773%	-0.275%	-0.744%	-0.475%	(0.76) -0.431%
												(-1.20)

Table 16: Portfolio Sorting: Call Options, Moneyness 0.975-1.025, Days to Maturity 60, All Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-1.072%	-0.953%	-1.126%	-0.904%	-0.604%	-0.322%	-0.377%	-0.439%	0.210%	0.656%	1.706% (4.12)***
1	pretret_earnat	-0.126%	0.269%	-0.160%	-0.298%	-0.916%	-0.625%	-0.648%	-0.706%	-0.932%	-0.745%	-0.575% (-1.46)
2	debt_ebitda	-0.991%	-0.531%	-0.817%	-0.824%	-0.198%	-0.310%	-0.530%	-0.757%	-0.462%	0.047%	1.049% (2.68)**
3	intcov_ratio	-0.287%	-0.191%	-0.330%	-0.116%	-0.583%	-0.273%	-0.842%	-0.683%	-0.876%	-0.631%	-0.317% (-0.68)
4	intcov	-0.087%	-0.267%	-0.567%	-0.024%	-0.184%	-0.593%	-0.565%	-0.990%	-0.634%	-0.927%	-0.763% (-1.78)*
5	ocf_lct	0.021%	0.066%	-0.341%	-0.576%	-0.459%	-0.705%	-0.596%	-0.940%	-0.755%	-0.547%	-0.504% (-1.27)
6	lnbm	-0.914%	-0.615%	-1.095%	-0.707%	-0.343%	-0.117%	-0.591%	-0.142%	-0.098%	-0.454%	0.442% (1.29)
7	lnme	-0.164%	-0.222%	-0.179%	-0.356%	-0.421%	-0.713%	-0.218%	-0.544%	-1.088%	-0.888%	-0.722% (-1.78)*
8	cgobeg	-0.745%	-0.342%	-0.370%	-0.751%	-0.578%	-0.403%	-0.418%	-0.545%	-0.804%	-0.254%	0.424% (1.10)
9	VPh60i30	-0.568%	-0.313%	-0.699%	-0.708%	-0.208%	-0.438%	-0.707%	-0.494%	-0.281%	-0.648%	-0.050% (-0.14)
10	fcf_ocf	0.210%	0.050%	-0.094%	-0.968%	-0.910%	-0.223%	-0.730%	-0.605%	-1.019%	-0.549%	-0.786% (-1.85)*

Table 17: Portfolio Sorting: Call Options, Moneyness 0.975-1.025, Days to Maturity 60, In-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-1.066%	-0.840%	-1.140%	-0.952%	-0.454%	-0.226%	-0.249%	-0.377%	0.231%	0.745%	1.788% (4.03)***
1	pretret_earnat	0.122%	0.270%	-0.152%	-0.042%	-0.940%	-0.563%	-0.728%	-0.552%	-1.001%	-0.683%	-0.797% (-1.84)(*)
2	debt_ebitda	-0.912%	-0.676%	-0.961%	-0.650%	-0.092%	-0.229%	-0.631%	-0.624%	-0.280%	0.158%	1.076% (2.38)**
3	intcov_ratio	0.007%	-0.274%	-0.170%	-0.103%	-0.441%	-0.309%	-0.641%	-0.752%	-0.917%	-0.653%	-0.633% (-1.23)
4	intcov	0.025%	-0.079%	-0.417%	0.157%	-0.239%	-0.744%	-0.464%	-0.832%	-0.703%	-0.997%	-0.936% (-2.00)**
5	ocf_lct	0.262%	-0.030%	-0.185%	-0.604%	-0.326%	-0.587%	-0.581%	-1.018%	-0.754%	-0.515%	-0.711% (-1.65)*
6	lnbm	-0.796%	-0.684%	-1.234%	-0.410%	-0.386%	-0.107%	-0.361%	0.020%	-0.251%	-0.295%	0.527% (1.32)
7	lnme	-0.090%	-0.006%	-0.217%	-0.546%	-0.087%	-0.568%	-0.193%	-0.458%	-1.194%	-0.903%	-0.810% (-1.86)*
8	cgobeg	-0.500%	-0.471%	-0.338%	-0.529%	-0.638%	-0.312%	-0.401%	-0.474%	-0.733%	-0.217%	0.205% (0.49)
9	VPh60i30	-0.581%	-0.200%	-0.547%	-0.505%	-0.206%	-0.313%	-0.540%	-0.594%	-0.224%	-0.900%	-0.291% (-0.79)
10	fcf_ocf	0.236%	0.016%	0.053%	-0.794%	-0.867%	-0.178%	-0.672%	-0.618%	-1.011%	-0.517%	-0.781% (-1.66)*

Table 18: Portfolio Sorting: Put Options, Moneyness 0.975-1.025, Days to Maturity 60, All Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-2.890%	-2.611%	-1.517%	-0.609%	-1.094%	-1.279%	-1.060%	-0.289%	0.871%	2.658%	5.542% (9.07)***
1	ret_1	2.606%	0.416%	-0.349%	-0.725%	-0.846%	-0.955%	-1.045%	-1.386%	-2.249%	-2.627%	-5.259% (-8.68)***
2	cgobeg	-0.499%	-1.202%	-1.190%	-0.315%	-1.209%	-0.781%	-0.569%	-0.878%	-0.651%	-0.677%	-0.410% (-0.77)
3	ptb	1.510%	0.260%	-0.379%	-0.548%	-1.282%	-0.888%	-1.375%	-1.480%	-1.417%	-1.629%	-3.152% (-6.02)***
4	aftret_invcapx	-0.250%	-0.288%	-0.623%	-0.930%	-0.556%	-1.081%	-1.128%	-1.269%	-1.057%	-0.746%	-0.579% (-1.29)
5	hv365	-0.742%	-0.860%	-0.985%	-1.057%	-0.612%	-0.741%	-0.725%	-0.935%	-0.528%	-1.114%	-0.490% (-0.91)
6	aftret_eq	-0.091%	0.045%	-0.916%	-0.422%	-1.223%	-1.158%	-0.949%	-1.384%	-0.814%	-1.047%	-0.802% (-1.71)*

Table 19: Portfolio Sorting: Put Options, Moneyness 0.975-1.025, Days to Maturity 60, In-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-2.897%	-2.901%	-1.785%	-0.910%	-1.416%	-1.380%	-1.079%	-0.131%	0.906%	2.188%	5.438% (7.23)***
1	ret_1	2.470%	0.229%	-0.331%	-0.668%	-1.114%	-1.091%	-1.124%	-1.518%	-2.454%	-3.055%	-5.516% (-7.23)***
2	cgobeg	-0.538%	-1.398%	-1.496%	-0.513%	-1.570%	-0.984%	-0.498%	-0.368%	-1.079%	-0.799%	-0.489% (-0.75)
3	ptb	1.993%	0.250%	-0.400%	-0.654%	-1.628%	-0.814%	-1.667%	-1.822%	-1.825%	-1.666%	-3.508% (-5.22)***
4	aftret_invcpx	0.238%	-0.349%	-0.493%	-1.164%	-0.874%	-1.157%	-1.322%	-1.558%	-1.174%	-0.923%	-1.095% (-1.70)*
5	hv365	-1.057%	-0.922%	-1.058%	-1.078%	-0.888%	-0.637%	-0.886%	-1.115%	-1.210%	-0.912%	0.258% (0.36)
6	aftret_eq	-0.027%	-0.101%	-1.030%	-0.471%	-1.492%	-1.216%	-1.206%	-1.271%	-1.096%	-1.115%	-0.772% (-1.20)

Table 20: Portfolio Sorting: Call Options, Moneyness 0.975-1.025, Days to Maturity 90, All Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-1.41%	-0.84%	-0.07%	-1.07%	-0.85%	-0.59%	-0.55%	-0.19%	-0.06%	0.61%	1.84%
												(2.28)**
1	ret_122	-1.74%	-0.67%	0.13%	-0.72%	-1.13%	-0.87%	0.11%	0.12%	-0.09%	0.76%	2.55%
												(2.64)***
2	VPh365i30	-1.52%	-1.41%	0.66%	-0.26%	-1.05%	0.05%	-0.77%	-0.26%	-1.05%	-0.08%	1.65%
												(2.21)**

Table 21: Portfolio Sorting: Call Options, Moneyness 0.975-1.025, Days to Maturity 90, In-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-1.406%	-0.878%	-0.027%	-1.025%	-0.848%	-0.635%	-0.548%	-0.174%	-0.053%	0.601%	1.888%
												(2.30)**
1	ret_122	-1.754%	-0.702%	0.159%	-0.672%	-1.106%	-0.913%	0.125%	0.113%	-0.085%	0.753%	2.661%
												(2.68)***
2	VPh365i30	-1.533%	-1.360%	0.637%	-0.330%	-1.025%	0.080%	-0.771%	-0.240%	-1.040%	-0.072%	1.771%
												(2.34)**

Table 22: Portfolio Sorting: Put Options, Moneyness 0.975-1.025, Days to Maturity 90, All Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-3.985%	-2.566%	-2.900%	-1.611%	-3.076%	-1.355%	-0.942%	-0.797%	2.394%	2.339%	6.172% (4.33)***
1	ret_122	-2.237%	-1.430%	-2.121%	-0.352%	-2.217%	-1.872%	-0.017%	-2.343%	0.040%	-0.652%	2.302% (1.25)
2	sale_equity	-4.102%	-1.550%	-1.608%	0.692%	-3.135%	-0.252%	-1.847%	-0.173%	-1.679%	0.251%	3.523% (2.09)**
3	ret_1	1.913%	0.257%	-0.245%	-0.547%	-1.910%	-1.106%	-2.090%	-1.863%	-3.314%	-3.181%	-6.100% (-2.67)***
4	de_ratio	-2.687%	-0.720%	-1.158%	-0.865%	-0.521%	-0.660%	-1.485%	-2.497%	-1.453%	-0.247%	1.710% (0.59)
5	cgobeg	-2.367%	-2.289%	-1.637%	-0.625%	-0.966%	-1.164%	-0.671%	-1.363%	-1.793%	-1.245%	2.016% (1.14)
6	inv_t_act	-2.174%	-1.351%	-2.135%	-1.239%	-1.180%	-1.167%	-0.340%	-2.114%	-2.237%	1.597%	1.992% (1.04)
7	pe_op_basic	-1.977%	-0.339%	-2.304%	-1.955%	-1.010%	-1.273%	-1.221%	-0.258%	-0.538%	-2.401%	-0.353% (-0.21)
8	pe_exi	-2.109%	-0.963%	-1.359%	-1.253%	-1.428%	-1.171%	-0.462%	-1.952%	-1.756%	-1.311%	1.551% (0.75)
9	ps	1.194%	0.246%	-1.914%	-0.803%	-0.878%	-1.497%	-1.139%	-0.468%	-2.812%	-4.688%	-6.773% (-2.38)**

Table 23: Portfolio Sorting: Put Options, Moneyness 0.975-1.025, Days to Maturity 90, In-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-3.981%	-2.598%	-2.909%	-1.605%	-3.088%	-1.424%	-0.911%	-0.915%	2.380%	2.424%	6.240% (4.29)***
1	ret_122	-2.207%	-1.474%	-2.136%	-0.342%	-2.281%	-1.892%	-0.096%	-2.237%	0.049%	-0.783%	2.388% (1.26)
2	sale_equity	-4.253%	-1.475%	-1.650%	0.664%	-3.124%	-0.207%	-1.944%	-0.297%	-1.682%	0.230%	3.770% (2.18)**
3	ret_1	1.986%	0.287%	-0.248%	-0.598%	-1.932%	-1.122%	-2.052%	-1.908%	-3.318%	-3.239%	-6.209% (-2.61)***
4	de_ratio	-2.850%	-0.694%	-1.166%	-0.851%	-0.573%	-0.701%	-1.431%	-2.501%	-1.544%	-0.223%	2.078% (0.69)
5	cgobeg	-2.291%	-2.302%	-1.614%	-0.725%	-0.975%	-1.191%	-0.769%	-1.333%	-1.827%	-1.206%	1.885% (1.04)
6	inv_t_act	-2.257%	-1.317%	-2.208%	-1.180%	-1.214%	-1.200%	-0.271%	-2.208%	-2.319%	1.584%	2.199% (1.12)
7	pe_op_basic	-1.863%	-0.401%	-2.221%	-1.969%	-1.131%	-1.248%	-1.239%	-0.253%	-0.549%	-2.561%	-0.491% (-0.28)
8	pe_exi	-2.001%	-1.025%	-1.289%	-1.334%	-1.447%	-1.177%	-0.417%	-2.080%	-1.796%	-1.360%	1.470% (0.69)
9	ps	1.317%	0.135%	-1.884%	-0.809%	-0.942%	-1.533%	-1.113%	-0.576%	-2.777%	-4.641%	-7.244% (-2.47)**

Table 24: Portfolio Sorting: Call Options, Moneyness 0.75-1.25, Days to Maturity 30, All Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-0.564%	-0.550%	-0.508%	-0.497%	-0.450%	-0.407%	-0.321%	-0.246%	-0.116%	0.327%	0.891% (5.11)***
1	ret_1	0.114%	-0.247%	-0.416%	-0.403%	-0.469%	-0.390%	-0.460%	-0.494%	-0.292%	-0.290%	-0.404% (-1.88)*
2	cgo_beg	-0.270%	-0.263%	-0.187%	-0.255%	-0.295%	-0.331%	-0.267%	-0.549%	-0.389%	-0.514%	-0.244% (-1.56)
3	hv122	-0.355%	-0.359%	-0.246%	-0.299%	-0.150%	-0.503%	-0.333%	-0.381%	-0.404%	-0.305%	0.050% (0.28)
4	ivol	-0.174%	-0.253%	-0.337%	-0.173%	-0.368%	-0.364%	-0.410%	-0.423%	-0.368%	-0.462%	-0.288% (-2.01)**
5	ocf_lct	-0.093%	-0.103%	-0.280%	-0.281%	-0.499%	-0.366%	-0.334%	-0.486%	-0.344%	-0.538%	-0.445% (-2.94)***
6	ior	-0.435%	-0.178%	-0.307%	-0.314%	-0.248%	-0.450%	-0.345%	-0.402%	-0.284%	-0.372%	0.063% (0.46)
7	VPh365i30	-0.770%	-0.588%	-0.375%	-0.386%	-0.332%	-0.329%	-0.251%	-0.131%	-0.116%	-0.064%	0.705% (5.35)***
8	fcf_ocf	0.151%	-0.417%	-0.428%	-0.415%	-0.320%	-0.313%	-0.350%	-0.394%	-0.346%	-0.506%	-0.657% (-4.45)***
9	npm	-0.212%	-0.206%	-0.193%	-0.371%	-0.293%	-0.403%	-0.315%	-0.443%	-0.318%	-0.572%	-0.360% (-2.43)**
10	lnamihud	-0.317%	-0.448%	-0.461%	-0.343%	-0.398%	-0.330%	-0.234%	-0.380%	-0.210%	-0.200%	0.117% (0.88)

Table 25: Portfolio Sorting: Call Options, Moneyness 0.75-1.25, Days to Maturity 30, In-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Returns	-0.575%	-0.511%	-0.462%	-0.519%	-0.370%	-0.371%	-0.325%	-0.311%	-0.143%	0.317%	0.892% (4.83)***
1	ret_1	0.054%	-0.233%	-0.394%	-0.380%	-0.481%	-0.365%	-0.474%	-0.485%	-0.238%	-0.288%	-0.342% (-1.57)
2	cgo_beg	-0.300%	-0.299%	-0.190%	-0.278%	-0.315%	-0.309%	-0.249%	-0.397%	-0.446%	-0.479%	-0.179% (-1.13)
3	hv122	-0.358%	-0.373%	-0.233%	-0.324%	-0.170%	-0.414%	-0.334%	-0.373%	-0.385%	-0.304%	0.054% (0.29)
4	ivol	-0.150%	-0.260%	-0.308%	-0.184%	-0.321%	-0.409%	-0.369%	-0.438%	-0.373%	-0.442%	-0.292% (-1.86)*
5	ocf_lct	-0.086%	-0.146%	-0.315%	-0.218%	-0.502%	-0.354%	-0.395%	-0.305%	-0.393%	-0.514%	-0.428% (-2.81)***
6	ior	-0.369%	-0.235%	-0.266%	-0.284%	-0.278%	-0.423%	-0.401%	-0.370%	-0.303%	-0.272%	0.096% (0.53)
7	VPh365i30	-0.812%	-0.624%	-0.334%	-0.377%	-0.293%	-0.355%	-0.169%	-0.139%	-0.124%	-0.050%	0.761% (5.62)***
8	fcf_ocf	0.124%	-0.414%	-0.398%	-0.355%	-0.314%	-0.309%	-0.273%	-0.391%	-0.392%	-0.491%	-0.615% (-4.08)***
9	npm	-0.175%	-0.255%	-0.199%	-0.385%	-0.318%	-0.337%	-0.303%	-0.455%	-0.321%	-0.507%	-0.333% (-2.04)**
10	lnamihud	-0.308%	-0.421%	-0.492%	-0.276%	-0.417%	-0.378%	-0.208%	-0.394%	-0.100%	-0.250%	0.058% (0.41)

Table 26: Portfolio Sorting: Call Options, Moneyness 0.75-1.25, Days to Maturity 30, Out-of-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-0.449%	-0.528%	-0.536%	-0.607%	-0.521%	-0.619%	-0.359%	-0.209%	0.020%	0.462%	0.911% (3.24)***
1	ret_1	0.402%	-0.170%	-0.476%	-0.392%	-0.577%	-0.380%	-0.525%	-0.596%	-0.397%	-0.222%	-0.624% (-1.86)*
2	cgo_beg	-0.160%	-0.141%	0.008%	-0.312%	-0.279%	-0.424%	-0.515%	-0.546%	-0.435%	-0.503%	-0.343% (-1.32)
3	hv122	-0.315%	-0.346%	-0.183%	-0.324%	-0.410%	-0.485%	-0.278%	-0.383%	-0.540%	-0.083%	0.232% (0.85)
4	ivol	-0.206%	-0.396%	-0.457%	-0.272%	-0.199%	-0.336%	-0.430%	-0.321%	-0.311%	-0.418%	-0.212% (-0.94)
5	ocf_lct	-0.152%	-0.078%	-0.171%	-0.601%	-0.387%	-0.267%	-0.432%	-0.396%	-0.500%	-0.424%	-0.272% (-1.09)
6	ior	-0.416%	-0.237%	-0.247%	-0.366%	-0.561%	-0.242%	-0.412%	-0.222%	-0.240%	-0.452%	-0.036% (-0.17)
7	VPh365i30	-0.653%	-0.482%	-0.372%	-0.386%	-0.484%	-0.234%	-0.193%	-0.171%	-0.346%	-0.027%	0.625% (2.82)***
8	fcf_ocf	0.014%	-0.542%	-0.238%	-0.556%	-0.435%	0.024%	-0.692%	-0.226%	-0.285%	-0.454%	-0.468% (-1.89)*
9	npm	-0.292%	-0.349%	-0.292%	-0.329%	-0.231%	-0.373%	-0.301%	-0.388%	-0.446%	-0.303%	-0.011% (-0.04)
10	lnamihud	-0.357%	-0.361%	-0.457%	-0.404%	-0.533%	-0.502%	-0.322%	-0.286%	-0.123%	0.003%	0.360% (1.63)

Table 27: Portfolio Sorting: Put Options, Moneyness 0.75-1.25, Days to Maturity 30, All Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-2.647%	-1.942%	-1.482%	-1.098%	-0.846%	-0.475%	-0.079%	0.315%	0.930%	2.668%	5.316%
1	ret_1	2.337%	0.927%	0.032%	-0.140%	-0.440%	-0.954%	-1.079%	-1.465%	-1.556%	-2.330%	(14.98)*** -4.667%
2	cgo_beg	-0.415%	-0.542%	-0.465%	-0.318%	-0.431%	-0.511%	-0.345%	-0.663%	-0.489%	-0.430%	(-12.28)*** -0.015%
3	money	-1.027%	-0.551%	-0.582%	-0.474%	-0.506%	-0.420%	-0.344%	-0.390%	-0.203%	-0.178%	(-0.05) 0.849%
4	ptb	0.496%	0.174%	-0.404%	-0.521%	-0.537%	-0.494%	-0.591%	-0.665%	-1.074%	-1.045%	(2.92)*** -1.541%
5	VPh60i30	-0.845%	-0.758%	-0.563%	-0.507%	-0.586%	-0.464%	-0.327%	-0.056%	-0.226%	-0.324%	(-5.52)*** 0.521%
6	ior	-0.615%	-0.312%	-0.120%	-0.414%	-0.578%	-0.440%	-0.485%	-0.462%	-0.553%	-0.663%	(2.40)** -0.048%
7	PEG_ltgforward	-0.091%	-0.099%	-0.108%	-0.290%	-0.429%	-0.585%	-0.832%	-0.569%	-0.798%	-0.872%	(-0.20) -0.781%
8	hv365	-0.358%	-0.530%	-0.530%	-0.549%	-0.436%	-0.528%	-0.608%	-0.703%	-0.363%	-0.036%	(-2.73)*** 0.322%
9	suv	-0.246%	-0.433%	-0.535%	-0.273%	-0.266%	-0.213%	-0.502%	-0.590%	-0.759%	-0.837%	(0.83) -0.591%
10	debt_at	-0.491%	-0.561%	-0.678%	-0.690%	-0.486%	-0.484%	-0.442%	-0.445%	-0.249%	-0.130%	(-4.00)*** 0.360%
												(1.50)

Table 28: Portfolio Sorting: Put Options, Moneyness 0.75-1.25, Days to Maturity 30, In-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-2.638%	-1.968%	-1.494%	-1.188%	-0.815%	-0.534%	-0.110%	0.326%	0.952%	2.496%	5.134%
1	ret_1	2.228%	0.879%	-0.016%	-0.063%	-0.498%	-1.028%	-1.162%	-1.399%	-1.541%	-2.384%	(14.44)*** -4.612%
2	cgo_beg	-0.428%	-0.524%	-0.524%	-0.226%	-0.579%	-0.580%	-0.417%	-0.638%	-0.460%	-0.578%	(-11.95)*** -0.150%
3	money	-1.084%	-0.613%	-0.582%	-0.516%	-0.572%	-0.451%	-0.407%	-0.381%	-0.174%	-0.209%	(-0.51) 0.875%
4	ptb	0.554%	-0.030%	-0.289%	-0.630%	-0.480%	-0.681%	-0.471%	-0.817%	-1.094%	-1.015%	(2.97)*** -1.569%
5	VPh60i30	-0.898%	-0.812%	-0.396%	-0.618%	-0.646%	-0.568%	-0.270%	-0.172%	-0.271%	-0.337%	(-5.28)*** 0.561%
6	ior	-0.673%	-0.354%	-0.184%	-0.296%	-0.665%	-0.526%	-0.525%	-0.416%	-0.649%	-0.675%	(2.58)*** -0.002%
7	PEG_ltgforward	-0.172%	-0.177%	-0.155%	-0.220%	-0.400%	-0.585%	-0.790%	-0.663%	-0.832%	-0.942%	(0.00) -0.770%
8	hv365	-0.403%	-0.586%	-0.544%	-0.585%	-0.422%	-0.661%	-0.604%	-0.596%	-0.401%	-0.178%	(-2.64)*** 0.225%
9	suv	-0.240%	-0.435%	-0.624%	-0.299%	-0.289%	-0.272%	-0.513%	-0.690%	-0.718%	-0.906%	(0.58) -0.666%
10	debt_at	-0.439%	-0.600%	-0.766%	-0.700%	-0.517%	-0.507%	-0.480%	-0.510%	-0.281%	-0.107%	(-4.22)*** 0.332%
												(1.28)

Table 29: Portfolio Sorting: Put Options, Moneyness 0.75-1.25, Days to Maturity 30, Out-of-sample Observations

Steps	Factors	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
	Predicted Return	-2.408%	-1.468%	-1.214%	-0.821%	-0.523%	-0.432%	-0.199%	0.401%	1.424%	3.015%	5.424%
1	ret_1	3.450%	0.852%	0.337%	-0.337%	-0.395%	-0.363%	-0.995%	-1.470%	-0.978%	-2.148%	(10.15)***
2	cgo_beg	-0.769%	0.017%	0.084%	-0.231%	-0.161%	-0.104%	-0.168%	-0.582%	-0.466%	0.269%	-5.598%
3	money	-0.422%	-0.285%	-0.441%	0.075%	-0.369%	-0.018%	-0.309%	-0.103%	-0.342%	-0.044%	(-9.89)***
4	ptb	0.486%	-0.010%	-0.017%	-0.323%	0.038%	-0.375%	-0.236%	-0.371%	-0.492%	-0.870%	1.038%
5	VPh60i30	-0.552%	-0.559%	-0.601%	-0.114%	-0.211%	-0.164%	-0.269%	-0.030%	0.454%	-0.178%	(2.47)**
6	ior	-0.117%	-0.190%	0.015%	-0.171%	-0.326%	-0.484%	0.127%	-0.314%	0.038%	-0.743%	0.379%
7	PEG_ltgforward	0.464%	-0.181%	0.278%	-0.303%	-0.261%	-0.318%	-0.538%	-0.349%	-0.400%	-0.708%	(0.75)
8	hv365	-0.252%	-0.236%	-0.224%	-0.191%	0.013%	-0.291%	-0.722%	-0.420%	-0.084%	0.187%	-1.356%
9	suv	-0.205%	0.152%	-0.169%	-0.170%	0.133%	-0.459%	-0.196%	-0.297%	-0.460%	-0.554%	(-2.87)***
10	debt_at	0.010%	-0.959%	-0.186%	-0.270%	-0.110%	-0.539%	-0.093%	0.136%	-0.566%	0.242%	0.374%
												(0.91)
												-0.625%
												(-1.30)
												-1.172%
												(-2.71)***
												0.439%
												(0.80)
												-0.349%
												(-1.17)
												0.232%
												(0.56)

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Table 30: Variable Descriptions

#	Variable	Source/Formula	Var Name
1	Standardized Unexplained Volume	Garfinkel and Sokobin (2006)	suv
2	Analyst Forecast Dispersion in Prior Month	Diether et al. (2002)	disp1
3	Capital gains overhang	Grinblatt and Han (2005)	cgobeg
4	Institutional ownership	Lehavy and Sloan (2008)	IOR
5	Moneyness	Current Stock Price / Strike Price	money
6	Open interest	Option Metrics IVY DB	open_interest
7	Logarithm of the market value of equity	Banz (1981) and Fama and French (1992)	lnme
8	Lagged one month return	Jegadeesh (1990)	ret_1
9	Cumulative return on the stock over the 11 months ending at the beginning of the previous month	Jegadeesh and Titman (1993)	ret_122
10	Cash-to-assets ratio	Palazzo (2012)	chr
11	Idiosyncratic volatility	Ang et al. (2006)	ivol
12	Income before extraordinary Items	Compustat - Capital IQ from Standard & Poor's	ib
13	Amihud stock liquidity measure	Amihud (2002)	lnamihud
14	Shillers cyclically adjusted P/E ratio	Compustat - Capital IQ from Standard & Poor's	CAPEI
15	Shareholder's equity	Compustat - Capital IQ from Standard & Poor's	BE
16	Logarithm of the book to market ratio	Compustat - Capital IQ from Standard & Poor's	lnbm
17	Enterprise value multiple	(Long term debt + Debt in current liabilities + Noncontrolling interest + Preferred stock + Price close*Common shares outstanding) / Earnings before interest	evm
18	Price/Operating earnings (Basic, Excl. EI)	Earnings per share from operations/Adjustment Factor (Company)	pe_op_basic

19	Price-to-earnings, excl. EI (diluted)	Earnings per share (diluted, excluding extraordinary items)/Adjustment Factor (Company)	pe_exi
20	Price-to-earnings, incl. EI (diluted)	Earnings per share (diluted, including extraordinary items)/Adjustment Factor (Company)	pe_inc
21	Price-to-sales ratio	Compustat - Capital IQ from Standard & Poor's	ps
22	Price-to-cash flow	Compustat - Capital IQ from Standard & Poor's	pcf
23	Dividend payout ratio	Dividends/Income before extraordinary items	dpr
24	Net profit margin	Income before extraordinary items/Sales	npm
25	Operating profit margin before depreciation	Operating income before depreciation/Sales	opmbd
26	Operating profit margin after depreciation	Operating income after depreciation/Sales	opmad
27	Gross profit margin	Gross profit/Sales	gpm
28	Pre-tax profit margin	Pretax income/Sales	ptpm
29	Cash flow margin	(Income before extraordinary items + Depreciation and amortization)/Sales	cfm
30	Return on assets	(Operating income before depreciation/Average of current and previous periods total assets	roa
31	Return on equity	Income before extraordinary items/Average of current and previous periods book equity	roe
32	Return on capital employed	Earnings before interest and taxes/(Average of current and previous periods long-term debt + Average of current and previous periods current debt + Average of current and previous periods common equity)	roce
33	After-tax return on average common equity	Income before extraordinary items/Average of current and previous periods common equity	aftret_eq
34	After-tax return on invested capital	(Income before extraordinary items + Interest and related expense + Noncontrolling interest)/(Previous period invested capital + Previous period deferred taxes and investment tax credit - Previous period noncontrolling interest)	aftret_invcapx
35	After-tax return on total stockholders equity	Income before extraordinary items/(Average of current and previous periods stockholders' equity)	aftret_equity

36	Pre-tax return on net operating assets	Operating income after depreciation/(Average of current and previous periods property, plant and equipment + Average of current and previous periods current assets - Average of current and previous periods current liabilities)	pretret_noa
37	Pre-tax return on total earning assets	Operating income after depreciation/(Average of current and previous periods property, plant and equipment + Average of current and previous periods current assets)	pretret_earnat
38	Gross profit to total assets	Gross profit/Total assets	GProf
39	Common equity to invested apital	Common equity/Invested apital	equity_invcap
40	Long-term debt to invested capital	Long-term debt/Invested capital	debt_invcap
41	Capitalization ratio	Long term debt/(Long term debt + Common equity + Preferred stock)	capital_ratio
42	Interest as % of average long-term debt	Interest and related expense/Average of the long-term debt of the current period and previous period	int_debt
43	Interest as % of average total debt	Interest and related expense/Average of the total debt of the current period and previous period	int_totdebt
44	Cash balance to total liabilities	Cash and short-term investment/Total liabilities	cash_lt
45	Inventory as % of current assets	Total inventories/Total current assets	invnt_act
46	Gross debt to ebitda	(Long term debt + Debt in current liabilities)/Earnings before interest	debt_ebitda
47	Short term debt as % of total debt	Debt in current liabilities/(Long term debt + Debt in current liabilities)	short_debt
48	Current liabilities as % of total liabilities	Current liabilities/Total liabilities	curr_debt
49	Long-term debt as % of total liabilities	Long term debt/Total liabilities	lt_debt
50	Profit before D&A to current liabilities	Operating income before depreciation/Current liabilities	profit_lct
51	Operating cash flow to current liabilities	Operating cash flow/Current liabilities	ocf_lct
52	Operating cash flow to total debt	Operating cash flow/Total liabilities	cash_debt
53	Free cash flow/Operating cash flow	Free cash flow/Operating cash flow	fcf_ocf
54	Total liabilities to total tangible assets	Total liabilities/Property,plant and equipment	lt_ppent

55	Long-term debt to book equity	Long-term debt/Book equity	dltt_be
56	Debt-to-assets	Total liabilities/Total assets	debt_assets
57	Debt-to-capital	(Accounts payable + Total debt)/(Accounts payable + Total debt + Common equity + Preferred stock)	debt_capital
58	Debt-to-shareholders' equity	Total liabilities/(Common equity + preferred stock)	de_ratio
59	Cash ratio	Cash and short-term investments/Current liabilities	cash_ratio
60	Quick ratio	(Current assets-Inventories)/Current liabilities	quick_ratio
61	Current ratio	Current assets/Current liabilities	curr_ratio
62	After tax interest coverage	(Interest and related expense + Income before extraordinary items)/Interest and related expense	intcov
63	Interest coverage ratio	Earnings before interest and taxes/Interest and related expense	intcov_ratio
64	Total debt as % of total assets	(Long-term debt + Current debt)/Total assets	debt_at
65	Receivables as % of current assets	Receivables/Current assets	rect_act
66	Cash conversion cycle	Average of current and previous periods inventories/Daily cost of goods sold + Average of current and previous periods receivables/Daily sales - Average of current and previous periods accounts payable/Daily cost of goods sold	cash_conversion
67	Inventory turnover	Cost of goods sold/Average of current and previous periods inventories	inv_turn
68	Asset turnover	Sales/Average of current and previous periods total assets	at_turn
69	Receivables turnover	Sales/Average of current and previous periods receivables	rect_turn
70	Payables turnover	(Cost of goods sold + Increase in inventories)/Average of current and previous periods accounts payable	pay_turn
71	Sales per dollar invested capital	Sales/Invested capital	sale_invcap
72	Sales per dollar total stockholders' equity	Sales/Stockholders' equity	sale_equity
73	R&D as % of sales	Research & development/Sales	rd_sale
74	Advertising as % of sales	Advertising expense/Sales	adv_sale
75	Labor expense as % of sales	Staff expense/Sales	staff_sale

76	Accruals/Average assets	(Operating activities - Net cash flow - Income before extraordinary items)/Average of current and previous periods total assets	accrual
77	Dummy of standard & poor 500	Compustat - Capital IQ from Standard & Poor's	sp500
78	Price-to-book	Market capitalization/Book equity	ptb
79	Forward P/E to 1-year growth (PEG) ratio	Price-to-earnings, excl. EI (diluted)/Expected EPS growth as of given month	PEG_1yrforward
80	Forward P/E to long-term growth (PEG) ratio	Price-to-earnings, excl. EI (diluted)/Analyst's mean estimate of EPS	PEG_ltgforward
81	Option's calculated realized volatility of the last 10 days	Option Metrics IVY DB	hv10
82	Option's calculated realized volatility of the last 14 days	Option Metrics IVY DB	hv14
83	Option's calculated realized volatility of the last 30 days	Option Metrics IVY DB	hv30
84	Option's calculated realized volatility of the last 60 days	Option Metrics IVY DB	hv60
85	Option's calculated realized volatility of the last 91 days	Option Metrics IVY DB	hv91
86	Option's calculated realized volatility of the last 122 days	Option Metrics IVY DB	hv122
87	Option's calculated realized volatility of the last 152 days	Option Metrics IVY DB	hv152
88	Option's calculated realized volatility of the last 182 days	Option Metrics IVY DB	hv182
89	Option's calculated realized volatility of the last 273 days	Option Metrics IVY DB	hv273
90	Option's calculated realized volatility of the last 365 days	Option Metrics IVY DB	hv365
91	At-the-money option's implied volatility over 30 days	Option Metrics IVY DB	iv30

92	At-the-money option's implied volatility over 60 days	Option Metrics IVY DB	iv60
93	At-the-money option's implied volatility over 91 days	Option Metrics IVY DB	iv91
94	At-the-money option's implied volatility over 122 days	Option Metrics IVY DB	iv122
95	At-the-money option's implied volatility over 152 days	Option Metrics IVY DB	iv152
96	Volatility premium: 365-day historical volatility less 30-day implied volatility	Option Metrics IVY DB	vph365i30
97	Volatility premium: 152-day historical volatility less 30-day implied volatility	Option Metrics IVY DB	vph152i30
98	Volatility premium: 91-day historical volatility less 30-day implied volatility	Option Metrics IVY DB	vph91i30
99	Volatility premium: 60-day historical volatility less 30-day implied volatility	Option Metrics IVY DB	vph60i30
100	Volatility premium: 152-day historical volatility less 60-day implied volatility	Option Metrics IVY DB	vph152i60
101	Volatility premium: 91-day historical volatility less 60-day implied volatility	Option Metrics IVY DB	vph91i60
