

## 1. Investment objective

The main goal of Millennium Capital is to outperform the market. We are an event-driven growth fund focusing on volatility inducing events. Our objective is to exploit high risk, high return volatility opportunities in a sustainable manner, by finding balance in total risk exposure and return potential.

## 2. Investment strategy

Research has shown that one of the most significant shifts in a stock price can occur around the release of earnings reports. The content of these reports is not of interest to us, as we do not rely on directional bets – instead we use straddles to maximize returns based on volatility itself. The likelihood of volatile shocks, after the release of the report, is our focus. To learn more about volatility caused by surprises in earnings releases, we focus on research about the dispersion of analysts' forecasts and possible trade strategies.

Early studies by Daley, Senkow, and Vigeland (1988)<sup>1</sup> have presented evidence that volatility in stock returns around earnings announcements is positively related to the dispersion of analysts' forecasts. Furthermore, Athanassakos & Kalimipalli (2003)<sup>2</sup> found a strong positive relationship between dispersion and future return volatility. Gao, Xing & Zhang (2017)<sup>3</sup> construct delta neutral straddles prior to earnings announcements which are held until the day of the announcement or one day after the announcement, which is similar to our final strategy. The returns are positively significant. This is not the case for straddles on regular trading days with no announcements. The effect is stronger for smaller firms and firms with higher past return volatility or highly volatile past earnings surprises. The results are more significant for firms with more dispersed analysts' estimates.

These findings form the basis of our trading strategy. Beyond our active trading strategy, we create a reasonable risk profile for the entire portfolio by allocating funds to a passive strategy that revolves around loading on prominent factors. Given the tendency that these passive funds are strongly correlated with the market, we also consider hedging instruments in case of bearish market sentiment. We keep track of premia on bear put spreads on the S&P 500.

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<sup>1</sup> Daley, L. A., Senkow, D. W., & Vigeland, R. L. (1988). Analysts' forecasts, earnings variability, and option pricing: Empirical evidence. *Accounting Review*, 563-585.

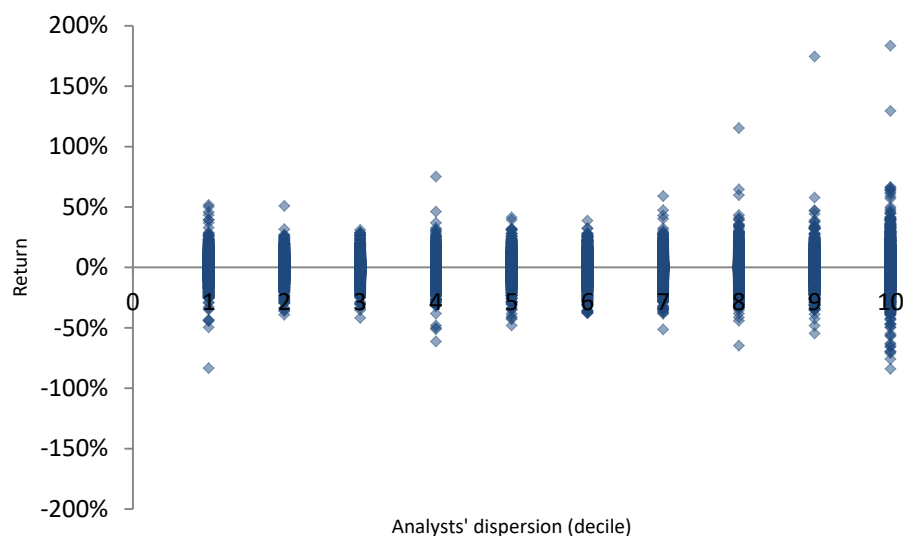
<sup>2</sup> Athanassakos, G., & Kalimipalli, M. (2003). Analyst forecast dispersion and future stock return volatility. *Quarterly Journal of Business and Economics*, 57-78.

<sup>3</sup> Gao, C., Xing, Y., & Zhang, X. (2017). Anticipating Uncertainty: Straddles Around Earnings Announcements.

### 3. Selection process

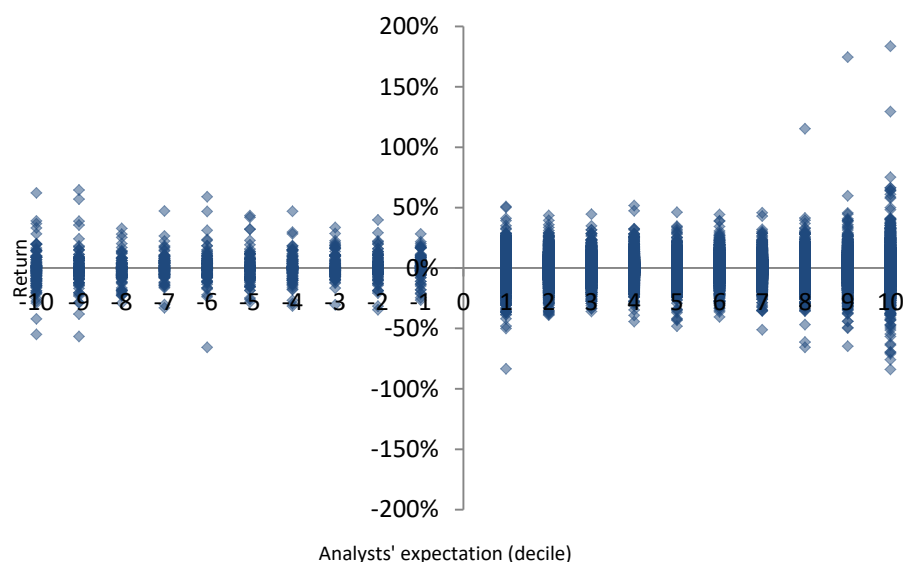
The selection criteria for finding straddles profiting from post-earnings volatility were formed based on our own empirical research. The findings, consisting of a sample spanning 2012 to 2016 with 34,137 events, confirm that the standard deviation of returns, calculated over a period spanning one day before and one day after the announcement<sup>4</sup>, is positively correlated with analysts' dispersion. Figure 1 provides insight in the distribution of post-announcement returns for ten deciles ranked by analysts' dispersion: events with the highest dispersed analysts' estimates (10) provide the most volatile returns.

Figure 1: Analysts' estimate dispersion (deciles) and post-announcement returns



Additionally, we found a similar effect for analysts' one year expectation on post-announcement returns. Figure 2 shows that more extreme earnings expectations (expected earnings relative to current earnings) result in relatively more volatile returns. This holds for both negative (-10) and positive (10) outlooks.

Figure 2: Analysts' one year expectation (deciles) and post-announcement returns



To profit from volatile return profiles (the highest ranked analysts' dispersion and expectation deciles) a vega<sup>5</sup>-maximized and delta-neutral straddle strategy will be tested. The setup of the straddle is to buy both a call and put position the day before the announcement. The options were selected based on a daily volume exceeding zero and the highest ratio of the average vega and the delta spread for the call and put combination. They were acquired at ask close prices, then the "loser" was sold at bid close price the day after the announcement, and the winner was

4 From now on: post-announcement returns

5 Vega is the measurement of an option's sensitivity to changes in the volatility of the underlying asset.

sold for the bid close after a 3 trading-day drift. The test was conducted on the same dataset by adding option pricing data. The option-linked sample size was 18,278 events. The results of the event study, shown in Table 1, indicate that this straddle strategy is most profitable for volatile post-announcement returns (ranked in the first column).

Table 1: Sorted absolute realized post-announcement returns and straddle returns

Absolute realized returns (decile)	Average straddle return (%)	Proportion of positive straddle returns (%)	Std. Dev. (%)	Skewness	Kurtosis	Count
10	75%	62.62%	211%	5.35	40.67	1,827
9	57%	52.63%	205%	5.37	39.03	1,828
8	56%	42.66%	257%	6.57	56.17	1,826
7	46%	40.45%	200%	6.10	57.10	1,827
6	53%	37.81%	275%	7.41	75.12	1,830
5	64%	38.51%	478%	20.09	519.49	1,828
4	40%	33.08%	298%	9.14	101.01	1,823
3	61%	34.06%	437%	16.32	400.51	1,832
2	42%	30.65%	327%	10.40	136.43	1,827
1	17%	22.51%	179%	8.84	111.36	1,830

The conclusion of the findings is that straddle positions should be initiated on stocks reporting earnings releases satisfying the following criteria:

- Analysts' dispersion measure  $= \frac{\text{std.dev.of est.EPS}}{\text{current share price}} \geq 0.56\%$
- Analysts' expectation measure<sup>6</sup>  $= \frac{\text{est.EPS}_{t+5} - \text{est.EPS}_{t+1}}{\text{current share price}} \geq 9.24\% \vee \leq -35.29\%$

After taking average daily trading volume into account, three prospects were selected. Given the high risk of the straddle strategy, as reported in Table 1, a small proportion of the funds (not exceeding 5%) was allocated to each straddle-trade. The remainder was allocated to passive ETF factor funds.

#### 4. Target clients and Benchmark

By optimally combining active and passive market investments, we create high returns within a reasonable zone of risk. This risk profile requires high net worth individuals with an aspiration for short-term wealth growth and an appetite for risk, thus they should not have short-term cash needs. This fund aims to create a diversified US equity portfolio. We downsize our investment universe, focusing on stocks that offer maximum upside potential for the investment horizon. Our investment strategy is characterized by relatively high uncertainty because the volatility of our returns is high with great upside potential. In line with our objective, the benchmark for our portfolio is the S&P 500 index.

#### 5. Portfolio and Investments

The portfolio consisted for 95% of passive investments. These assets were popular ETFs loaded with low-volatility, momentum, quality, size and value factors or a combination of them. A (near) net-zero investment was allocated towards a beta-hedge, which was constructed by the bear put spread principle (long put & short put at different strikes). The remaining 5% was allocated towards the straddle strategy. The ETFs and market hedge are labeled as the (enhanced) passive portfolio, while the straddle strategy is labeled as the active portfolio.

<sup>6</sup> When the est.  $\text{EPS}_{t+1}$  is positive and the est.  $\text{EPS}_{t+5}$  is negative, then the nominator was replaced by  $-1 * (\text{est. } \text{EPS}_{t+1} - \text{est. } \text{EPS}_{t+5})$ .

Table 2: Portfolio summary

Symbol	Class	Group	Factor(s)	Quantity	Market value	Weight	Returns	Weight. returns
SMLV	ETFs	Passive	size & low-vol	2650	\$227,529	24.77%	-8.16%	-2.02%
EQAL	ETFs	Passive	beta	7766	\$233,135	24.91%	-6.42%	-1.60%
IWX	ETFs	Passive	size & value	4586	\$234,207	24.88%	-5.86%	-1.46%
ONEO	ETFs	Passive	value, quality, size & momentum	3257	\$234,642	24.63%	-4.73%	-1.17%
XL1816B39	Options	Straddle	vega	390	\$51,870	1.91%	171.43%	3.28%
XL1820P40	Options	Straddle	vega	48	\$14,880	2.04%	-27.06%	-0.55%
AI1820P10	Options	Straddle	vega	20	\$600	0.14%	-57.14%	-0.08%
AI1820D10	Options	Straddle	vega	25	\$2,500	0.15%	66.67%	0.10%
SPY1816O273	Index options	Market Hedge	negative beta	44	\$12,188	3.21%	-62.00%	-1.99%
SPY1816O264	Index options	Market Hedge	negative beta	-65	\$(30,745)	Short position		3.07%
SPY	Index	Passive	beta	955	\$262,348	25.55%	2.70%	0.69%
CHK1918M4	Options	Straddle	vega	199	\$28,258	2.75%	2.90%	0.08%
CHK1918A4	Options	Straddle	vega	614	\$36,226	2.82%	28.26%	0.80%
VOO	ETFs	Passive	beta	830	\$209,567	20.22%	3.65%	0.74%
IVV	ETFs	Passive	beta	940	\$260,117	25.11%	3.61%	0.91%
XLF	ETFs	Passive	financials	8893	\$258,964	24.82%	4.34%	1.08%
Portfolio return	1.28%							
Market return	-1.42%	Portfolio Std. Dev.	0.75%					
Annualized alpha	17.65%	Sharpe Ratio Portfolio	1.69					
Beta	0.42	Sharpe Ratio Market	-1.43					

### a. Portfolio Performance

The entire portfolio had a total return of 1.28%, beating the benchmark of -1.42% quite substantially. Our annualized alpha is a staggering 17.65%. With a Sharpe ratio of 1.69 we can confidently state that we successfully managed risk, without compromising return. The low standard deviation of 0.75% is much more forgiving than we had anticipated. This measure is surprising, given the high standard deviations of our strategy as reported in Table 1. Furthermore the beta of the portfolio is quite low overall, even though we had 95% allocated towards ETFs that were highly correlated with the market. This is indicative of a successful attempt to diversify away from bearish market sentiment.

The (enhanced) passive portfolio had ETFs loaded with 6 factors (or combinations of them): size & low-volatility, beta, large size & value, value, quality, small size & momentum, negative beta and financials. The performance of this portfolio is displayed in figure 3a. Overall the findings indicate a disappointing performance of the passive portfolio starting the 5th of February. The portfolio recovers from this negative shock at the 7th of February, when we initiated a bear put spread hedge. We outperformed the market in cumulative returns by 3.7% over the next three trading days. After that period market sentiment improved. Our active portfolio performed impressively, as displayed in figure 3b. It's worth noting that besides its phenomenal performance, the active portfolio had also been unaffected by bearish sentiment.

Figure 3a: Passive portfolio timeseries

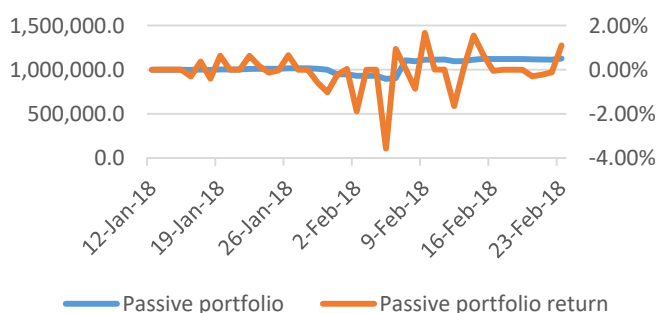
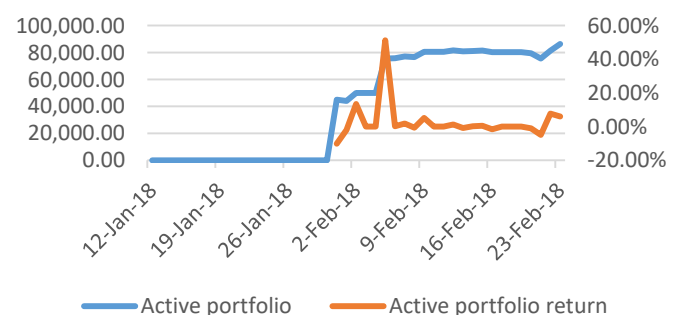


Figure 3b: Active portfolio timeseries



### b. Top Performers

Our best performing trades were part of the straddle strategy. The first straddle was initiated on XL Group (XL), where the “winner” position was the call with a yield of 171% and a net return of 68.9% on the invested amount. On the total portfolio (assuming a starting value of \$1 M) this trade generated 3%. The second best performing trade was our hedge strategy for bearish sentiment on the S&P500. On the 5th of February we experienced a large drop in US equity indices and a significant spike in the VIX index, also known as the “February funk”. We reacted on this by initiating a bear put spread on the SPY at strikes 273 and 264. The inflated option premia due to the spike in volatility paid off quite well: a net return of 1.08% on the total portfolio. In hindsight we timed the market correctly with this trade. In third place was the Financial Select Sector SPDR ETF (XLF), with increased supply sided inflationary pressure and higher average hourly earnings, we expected financials to outperform the index. The fourth best performing trade was on the Chesapeake (CHK) straddle, after the midterm ranking, with a net return of 16%. The underlying factors that provided this success were vega, interest rates and earnings drift.

### c. Underperformers

Most of our passive investments underperformed our expectations. We expected a gradual rise in US stock prices, without periods of significant downside performance. Our passive funds dropped significantly in value due to a correction in the markets (February funk). Our most disappointing position was the SPDR SSGA US Small Cap Low Volatility Index (SMLV). We expected this fund to perform slightly worse than the others in bull markets and to outperform them during bear markets. Not only did it significantly underperform during rising markets, but it also underperformed during the market correction. The latter may have been due to the short duration of this bearish sentiment, while the low-volatility factor appears to be designed to work well in a longer time horizon. Overall, the passively managed funds underperformed expectations.

### d. Midterm Ranking

We analyze our fund’s risk before and after the midterm ranking. Since the midterm ranking is when we were rewarded with new clients, we tried to get the best return before the midterm ranking. We found that the majority of our risky trades occurred before that time. We initiated straddle positions on XL Group (XL) and Arlington (AI) before February 2nd. Our overall portfolio seems to exhibit higher risk before the midterm based on several metrics provided in Table 3. After the midterm ranking, our fund has a lower standard deviation and a lower correlation with the market.

Table 3: Performance measures before and after midterm ranking

Pre-midterm					Post-midterm				
	Returns	Std. Dev.	Sharpe ratio	Market Correlation		Returns	Std. Dev.	Sharpe ratio	Market Correlation
Passive	-0.57%	1.62%	-0.35	60.55%	Passive	0.20%	1.17%	0.17	38.62%
Active	15.74%	24.66%	0.64	-90.32%	Active	1.15%	3.58%	0.32	32.76%
Market	-0.16%	1.32%	-0.12	100%	Market	0.12%	1.02%	0.12	100%

## 6. Lessons from portfolio management

One of the main issues in our strategy was liquidity. Many companies did not meet our requirements of option volume to employ our strategy. And even in our final prospects the extent to which we could implement our straddle strategy was slightly disappointing due to the option volume and the accompanied bid-ask complications. Second, the information in earnings reports is very valuable. The uncertainty about the actual figures causes strong fluctuations in stock prices. We trade on volatility, so it’s important to analyze information and estimate how volatile a stock will be after the earnings announcement. Third, the economic environment should always be considered. The economic environment will definitely influence the performance of options. This was confirmed by the strong correlation between VIX spikes on Monday (the February funk “mini-crash”) and the option premia in general. Our vega-sensitive strategy benefited greatly from this event. We should be sensitive to the market sentiment, and make plans about our strategies in both bullish and bearish market. The last lesson we learnt from portfolio management was that factors are not a guarantee for success and that versatility in terms of responding towards market dynamics can also play a very important role in generating returns.