Second Quarter 2017 Letter

Welcome to your Q2 2017 quarterly letter from Burr Capital LLC.

During the first half of 2017, Burr Capital LLC aggregate accounts posted 23.9% compared to 9.3% for the S&P 500. Our objective is to achieve long-term performance superior to that of the S&P 500. Since Jan '16, the annual compounded rate for Burr Capital LLC is 32.3%, which is almost 18 points higher than the 14.4% for the S&P 500. Please remember that past performance may not be indicative of future results and individual accounts may vary significantly (please see the **Disclosures** section at the end of this letter for more information). Exhibit 1 provides a summary of results to date:

Exhibit 1

		S&P 500	Burr Capital LLC
2016	1st Qtr (Mar)	1.4%	-2.3%
	2nd Qtr (Jun)	2.5%	8.1%
	3rd Qtr (Sep)	3.9%	11.7%
	4th Qtr (Dec)	3.8%	4.1%
	2016 Full Year	**12.0%**	**22.8%**
2017	1st Qtr (Mar)	6.1%	12.1%
	2nd Qtr (Jun)	3.1%	10.6%
	3rd Qtr (Sep)		
	4th Qtr (Dec)		
	2017 YTD*	**9.3%**	**23.9%**
	Cumulative Results**	**22.4%**	**52.2%**
	Annual Compounded Rate**	**14.4%**	**32.3%**

* For the period 01/17-06/17
** For the period 01/16-06/17

Our investing algorithm—concentrated portfolio, high active share, and options hedging—is simple and repeatable but not easily implemented:

1. Concentrated portfolio: Our portfolio, with 18-20 stocks and five-year holding periods, requires only 3-4 high quality investment ideas per year. In contrast, the institutional imperative to own hundreds of stocks, in the name of diversification, can lead to a large number of low quality investments to fill the pipeline.
2. High active share: We don't own the tech giants—Facebook, Amazon, Apple, Google, and Microsoft—which accounted for about 40% returns for the S&P 500 this year. According to a Wall Street Journal report, 80% of actively managed funds own two or more of these stocks. We believe that owning a portfolio that differs materially from the S&P 500 index can lead to long-term outperformance, whereas a fund that "hugs" the index underperforms, after fees and commissions.
3. Options hedging: When markets are elevated, as they are today, hedging the portfolio is imperative to protect capital. Options have an elegant symmetry that provide certain benefits, such as the ability to define risk and lower borrow costs, over shorting stocks.

Portfolio Review

As a reminder, your portfolio is structured in three parts:

- A growth sub-portfolio, where we hope to achieve a 15-25% return over 3-5 years.
- An income sub-portfolio, with high-yielding preferred and common equity that produces income and stabilizes the portfolio.
- Options to hedge the portfolio.

We mainly invest in US domestic businesses where we're comfortable with the financial reporting and management incentives, and when required, we can pick up the phone or hop on a plane to meet with management. We see no need today to venture to other locations to find good investments.

Noteworthy **contributors** to performance in the second quarter were our investments in Liberty Interactive (QVCA) and CommerceHub (CHUBK).

- QVC is a wonderful recurring cash flow shopping-as-entertainment media business with a loyal consumer base and quirky entrepreneurial suppliers (*Shark Tank* anyone?) trading at an attractive valuation. Shareholder-friendly management continues to aggressively buy back shares, effectively increasing our proportional ownership in the business.
- CommerceHub is an asset-light arms dealer in the e-commerce supply chain with no direct comparable firms and a massive untapped addressable market. If the business isn't acquired, it could grow to multiples of its current size.

Detractors to performance were Discover Financial (DFS) and our oil investment.

- Discover Financial is the Rodney Dangerfield of the credit card industry. It gets no respect even though Discover cards have nearly the same US merchant acceptance coverage as Visa/MasterCard. They also charge lower fees to merchants and offer superior rewards to consumers. Discover has a strong balance sheet, the shares are attractively priced and management continues to buy back

shares with its free cash flow, effectively increasing our proportional ownership in the business. Discover is also a beneficiary of rising interest rates and domestic tax reform.

- Someone I greatly respect said the key to being a good investor is when you're wrong, which you'll invariably be, you quickly own up to your mistakes and cut your losses. We made an ill-timed investment in oil, described in our previous letter, which has cost us around 1% in performance this year. Energy has been a difficult area to invest in over the last 3-4 years and may remain that way for a while. For now, we hold on to our investment to collect the income, which lowers our cost basis, and plan to sell this loser by year-end to harvest the tax loss.

Adding Machine Learning (ML) to a Latticework of Mental Models

ML was the topic *du jour* in the last quarter and inspired this section. NVIDIA CEO Jensen Huang gave a powerful two-hour (unscripted?) keynote address at the GPU Technology Conference. Please watch it, if you haven't done so, and follow up with Stanford University Prof. Fei-Fei Li's computer vision talks on teaching computers to understand pictures. It's an exciting time to be a data scientist.

Why do fundamental investors fear machines?

A recent WSJ article featured a debate on machines versus humans. A fundamental investor argued that *"Brains Are More Reliable Than Machines"* and a quantitative hedge fund manager claimed *"Quants Are Better Than the Brains."*

The fundamental investor wrote *"investment success involves untangling behavioral problems through slow, hard, qualitative analysis."* Let's unpack this claim. Business value is determined by its underlying cash flows. Stock prices can be distorted by behavioral biases in the short term. Without these biases, value and price would never diverge. Ben Graham, the father of value investing, said in the short run the market is a *"voting machine"* (i.e., a beauty contest) and in the long run a *"weighing machine."* Stock prices tend to converge with business value over time. So a machine trained to derive business value and wait for a large divergence between value and price to buy/sell could become a successful fundamental investor without a need to untangle *"behavioral problems."* There's also no requirement that any such analysis be *"slow"* or *"hard."* The fundamental investor goes on to claim *"great investors don't require great quantities of information."* This seems to fly in the face of everything we know about great investors who all have one thing in common—they're information sponges (Warren Buffett spends 80% of his day reading!).

The quantitative manager argued that *"use of the scientific method helps us combat a wide range of harmful but common cognitive and emotional biases"* and *"the availability of massive amounts of data and cutting edge technology only magnifies the power of the scientifc approach."* The kind of information he refers to (e.g., tracking satellite data, web traffic, sensors) is great for short-term trading. But what's missing today is a large enough dataset of great long-term investments (such as Amazon,

Apple, Google, Coca Cola, and American Express) to train a machine. According to research by Prof. Hendrik Bessembinder of Arizona State, less than 1.1% of all stocks in the period 1926-2015, created three-quarters of the stock market's cumulative dollar gains relative to cash in that period. Think about that for a minute. ML needs data, lots of it. But the great investments are the outliers where the data is sparse. In the world of investing, we aren't in Lake Wobegon, yet.

Undoubtedly, in time, as we gather more data, fundamental investing will also be conquered by ML. Till then, fundamental investors and machines will continue to operate in orthogonal planes with no overlap, creating large white spaces for opportunisitic investors to thrive.

How did we get here?

Artificial intelligence (AI) research was born in 1956 at Dartmouth. Machine learning (ML), a path to AI, came into its own in the '80s. Elegant ML algorithms were developed, inspired by the brain (neural networks), evolution (genetic programming), logic (inverse deduction), probabilities (Bayes) and analogy (nearest neighbors). But after years of rapid development, scientists hit a brick wall due to two fundamental problems: limited data and insufficient computing power. Then something shifted over the last decade:

- "Signing" a social pact: A social pact was "signed" with humans handing over all their personal data (activities, likes/dislikes, friends, cat pictures, etc.) and businesses promising products that delight and services that are free, leading to an explosion in data.
- "Bending" Moore's Law: The rise of graphics chips (built for matrix calculations) in ML and the advent of ubiquitous rentable cloud computing, led to step function increases in computing effectively "bending" Moore's Law.

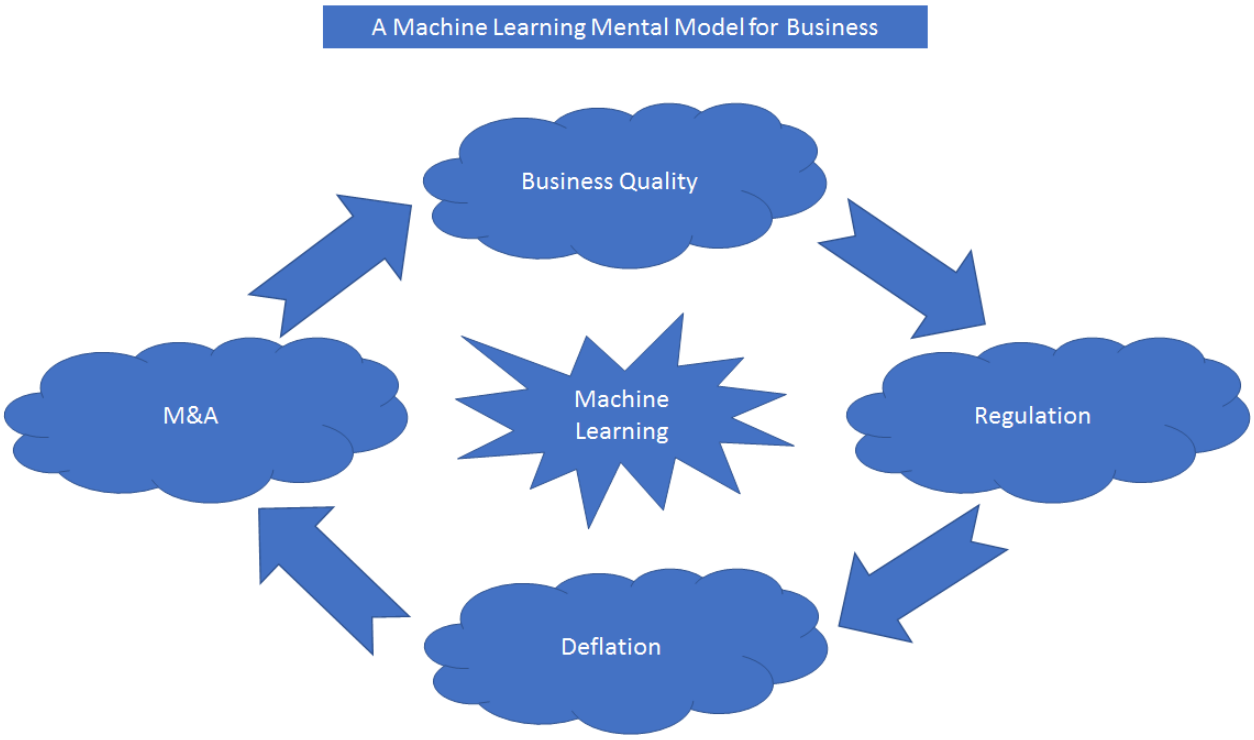
ML enables Google to predict what we're going to type (or say) next, Amazon to suggest items to buy, Netflix to recommend shows to watch, Yahoo to spot spam, and Amazon Echo to do pretty much anything. Welcome to the big bang of ML.

A machine learning (ML) mental model for business

Charlie Munger said one must "hang experience on a latticework of [mental] models" [of big ideas from big disciplines] to be a successful investor and thinker. Munger's 100-or-so mental models are wide-ranging from math (compound interest) to psychology (the power of incentives). ML deserves a preferred place on this list, both as a construct on how to view the changing business landscape (i.e., a checklist), and as an analytical tool (like statistics). We start with the former and tackle the latter in a subsequent section.

In an ML world, businesses that own proprietary actionable data will dominate their industry, inviting regulatory scrutiny and deflationary pricing. The also-rans will scramble to catch up with frenzied M&A or risk disintermediation. Exhibit 2 provides a visual of this emerging dynamic.

Exhibit 2



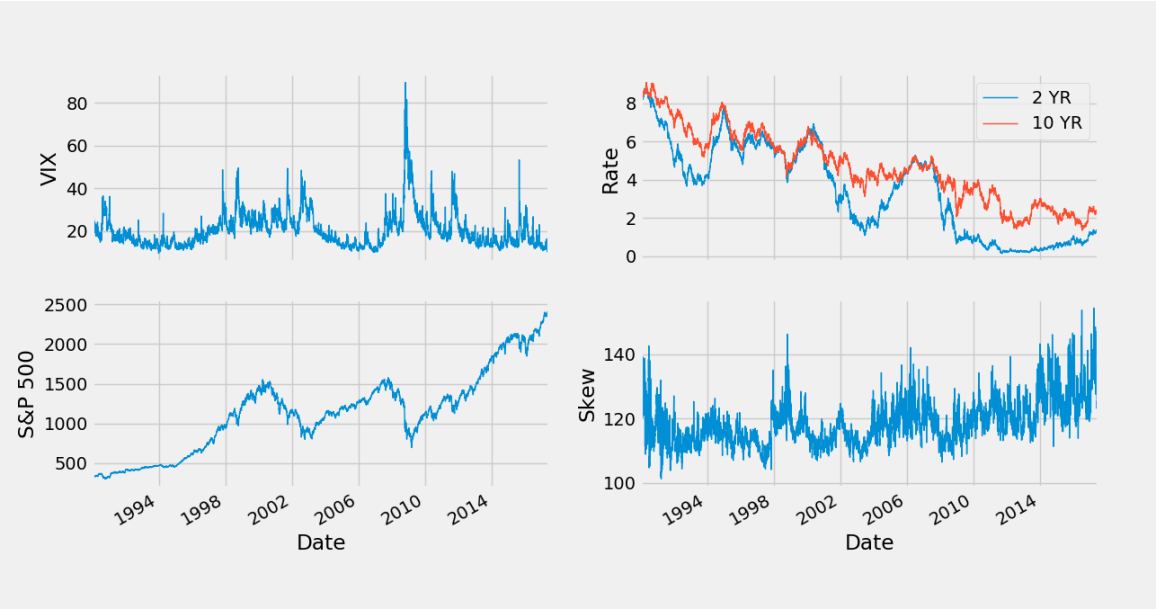
- Business quality: Businesses with proprietary actionable data will become increasingly valuable.
    - In an interesting parallel, it took fundamental investors a decade to learn how to value software-as-a-service (SaaS) subscription models. When Synopsys announced a transition to ratable from perpetual licenses, back in 2004, its shares sank. But more recently, when Adobe announced a similar transition, its shares soared. We're now comfortable valuing SaaS companies using non-traditional metrics like Lifetime Value (LTV), Customer Acquisition Costs (CAC), and churn.
    - Similar metrics for actionable data (Data Lifetime Value, Data Acquisition Costs, and Data Half-life) may be needed to value ML-intensive businesses.
    - Cloud-enabled ML "Fred-in-the-shed" startups will disrupt many industries.
    - **Every investment will include a "technology" ML component. Sorry Charlie Munger, we must all become "surfers."**
- Regulation: The creation of monopoly utilities (Google, Facebook, and Amazon) with proprietary actionable data will invite regulatory scrutiny, like banks and legacy utilities.
- Deflation: Data-driven business models will drive deflationary pricing which will be bad for businesses and mixed for consumers.

    - ML will spawn more free services, subsidized by advertising spend.
    - For businesses:
        - The monopoly utilities (Google, Facebook, and Amazon) will squeeze out smaller players with deflationary pricing but won't be able to monetize their advantage due to regulation.
    - For consumers:
        - On the one hand, purchasing power will increase with more spent on experiences, like live events.
        - On the other hand, jobs in traditional inflationary industries, like retail and oil, will be disrupted.
- M&A: Deflationary forces will lead disadvantaged companies to frenzied M&A.
    - Like wireless spectrum, there will be "good" and "bad" data.
    - Some like Visa, Intuit, Facebook, Amazon, Apple, Netflix, and Google will own the good data.
    - Others will make questionable deals in the hunt for good data.
        - AT&T buying Time Warner
        - Verizon buying Yahoo (Oath?)

Machine learning (ML) is statistics on steroids

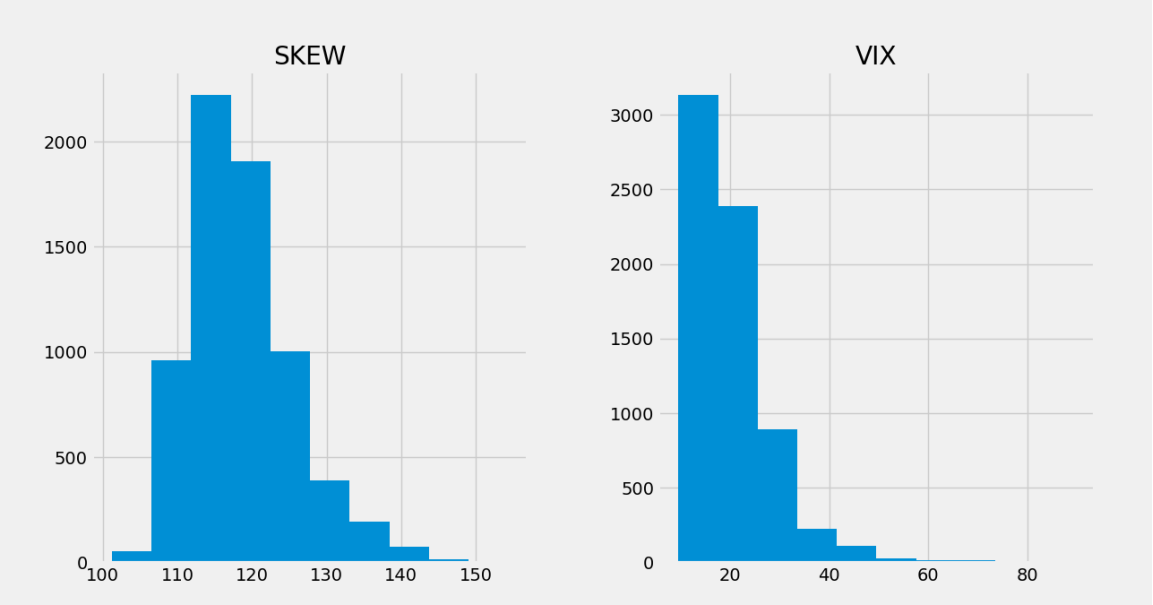
ML shines when we have large amounts of "good" data, unlimited computing resources, a large feature set, and a well-defined objective that can drive supervised learning. In the context of financial markets, one could envision a well-defined objective as predicting a move in the VIX Index over the next 30 days. The VIX index is like a "fear" index because the VIX rises when investors get nervous. One could construct an experiment with a feature set comprising the 2-year and 10-year US treasury rates, the S&P 500 stock price level, the S&P 500 Skew, and the VIX (Exhibit 3 plots these features).

Exhibit 3



Skew is a measure of the relative price of a put option versus a call option. A Skew of 100 suggests an equal (perceived) probability of a rise or fall in the S&P 500 but as the Skew rises above 100, investors perceive a greater probability of a fall in prices. You can see in Exhibit 4 that the historical median Skew is around 120 suggesting investors are more fearful of a fall than are excited by a rise in prices (loss aversion).

Exhibit 4



Machine learning (ML) to predict a rise in the VIX

A rise in the VIX may indicate that market participants are getting more nervous about an imminent correction in stock prices.

Using financial prices over the time period 1990-2017, we trained seven ML models to answer the following question: *Will the VIX on average rise over the next month?*

A caveat: This experiment is not designed to predict sharp spikes in the VIX, which are usually accompanied by a major event (like 9/11, a financial crisis, or Brexit), but rather to detect vulnerabilities to such destabilizing events.

Of the models trained and tested, the CART model performed the best with 77% accuracy and minimal bias towards either "Yes" or "No" predictions. Exhibit 5 summarizes the results.

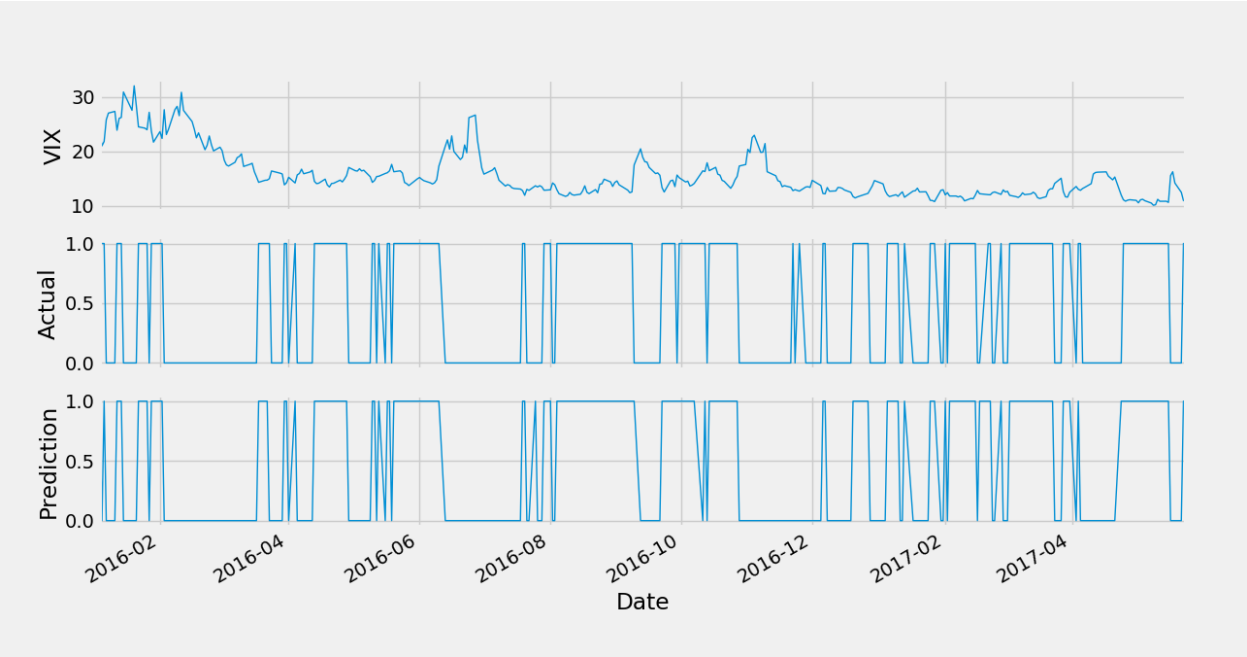
Exhibit 5

Model	Accuracy[1]
Logistic Regression	60.2%
Linear Discriminant Analysis	60.3%
K-Nearest Neighbor (KNN)	73.5%
Classification & Regression Tree (CART)	**77.0%**
Gaussian Naïve Bayes	59.4%
Support Vector Machine (SVM)	76.0%
Multi-Level Perceptron (MLP)	57.4%

[1] Accuracy: Fraction of correct predictions on the test/validation data

Exhibit 6 plots the CART model's predictions versus the actuals and the VIX. This is only a snapshot rather than the entire time series so we can zoom into the most recent period. It seems the model is able to correctly detect the mean-reverting nature of the VIX, predicting a decline after a sharp rise and an increase after an extended decline.

Exhibit 6



Machine learning (ML) to predict a rise in the S&P 500

We also trained the ML models to answer a different but related question: *Will the S&P 500 rise over 5% in the next month*?

Of the seven models trained and tested, the KNN model performed the best with an impressive 90% accuracy. Exhibit 7 summarizes the results of this experiment.

Exhibit 7

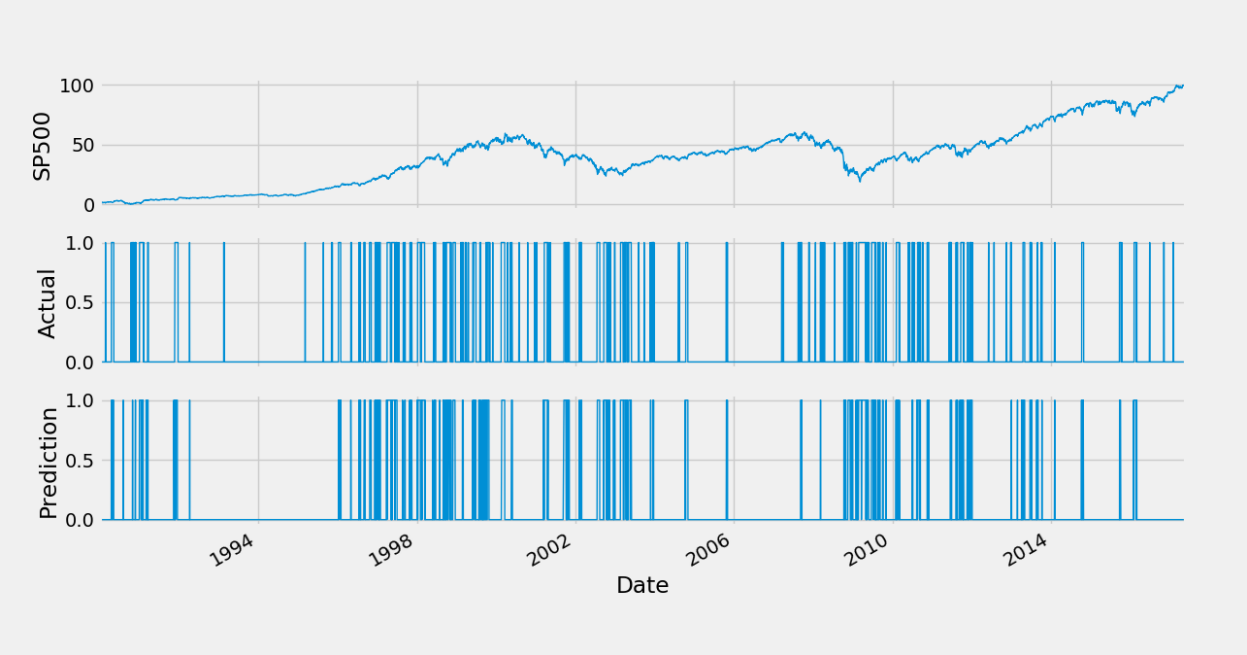
Model	Accuracy[1]
Logistic Regression	86.4%
Linear Discriminant Analysis	86.0%
K-Nearest Neighbor (KNN)	**90.1%**
Classification & Regression Tree (CART)	88.7%
Gaussian Naïve Bayes	85.9%
Support Vector Machine (SVM)	88.3%
Multi-Level Perceptron (MLP)	86.6%

[1] Accuracy: Fraction of correct predictions on the test/validation data

Exhibit 8 plots the KNN model's predictions versus the actuals and the S&P500. The model shows a conservative bias (compare the fewer solid regions in the "Prediction" chart versus the "Actual" chart) which is also confirmed by its higher "No" versus "Yes" prediction accuracy. This highlights the

somewhat surprising observation that even though the market has been rising in the 1990-2017 time period, a whopping 85% of the time the market did not rise more than 5% in any month.

Exhibit 8



Firm Update

That was a lot to digest. A final note before closing: we're pleased to report the firm's inclusion into Morningstar's and eVestment Alliance's investment manager databases. We have no doubt that their institutional distribution and analytics will be great assets for our long-term growth.

Thank you again for your support and please do not hesitate to reach out if you have any questions.

Sincerely,

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DISCLOSURES

Please remember that past performance may not be indicative of future results. The Burr Capital LLC aggregate account is based on the aggregate performance of all client accounts (existing and new accounts opened during the year at various times) except those client accounts that place any restrictions on investing in options. Two personal IRA accounts with restrictions on trading in options were excluded from the aggregate. Burr Capital LLC accepted one outside client in November 2015; returns are therefore computed from 2016 onwards.

Performance of individual accounts may differ significantly from Burr Capital LLC aggregate account, depending on timing of investments, the effects of additions, and the impact of withdrawals from the account. Not all accounts have identical securities and weightings. Portfolio holdings and weightings may vary depending on the size of the account, especially accounts below $200,000. For example, due to liquidity constraints, it may not be possible to own fixed income securities or to implement certain option strategies in smaller accounts.

Figures are unaudited and may not include impact of accrued but unpaid fees for the latest quarter. S&P 500 returns include dividends but do not reflect any fees. Returns are computed on a before-tax time-weighted return (TWR) basis and are net of all paid management fees and brokerage costs. As of 12/30/2016, approximately 55% of the aggregate assets represented non-fee-paying assets.

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