

Machine Learning and Algorithmic Trading

In Fixed Income Markets



Algorithmic Trading, computerized trading controlled by algorithms, is natural evolution of security markets. This area has evolved both in academic and real worlds. Most of academic studies suggest it has positive impact on market quality and efficiency. All major Algo players supply substantial liquidity and contribute to the price discovery for the benefits of all market participants. Like traders, Algorithms can be designed to observe market in real time and take trading decisions without human intervention. A variety of algorithms are used today to look for arbitrage opportunities, achieve optimal execution of large orders at minimum cost and market impact, seek alpha through a longer term strategies, and to acquire position for hedging. These algorithms could be cost driven or benchmark driven, risk-neutral or risk-averse, and use advance quantitative and computational techniques as they work through time and across markets.

Spread Algorithms

Spread trading is integral part of fixed income business. More about the algorithmic spread trading on

Page 2

Machine Learning

Machine learning is the most advanced data analysis technique applied in practically all fields today. More on

Page 4

Market Making

Market making desks across the streets are utilizing technology to keep their edge of constant narrowing spreads. More on

Page 5



Tweet Crash

April 23rd 1:08 PM: Stocks briefly erased a 125-point gain after a tweet from the Associated Press Twitter account erroneously claimed that there were two explosions in the White House and that President Barack Obama had been injured - Dow Jones Kaitlyn Kiernan

These moves appear to be completely machine driven. These are probably the algos reading news headlines. Although there is a lesson learned here but this incident has clearly demonstrated the extent of use of machine in trading in today's world.

The drive of automation has occurred in most industries. Now it seems to be the turn of Treasury, Corporate Bonds, Muni, Commodities and Credit products to take the leap. These markets are being confronted with both regulatory pressure and need for a greater efficiency. Comparatively, these products present their own unique microstructures such as the Interest Rate Futures listed on CME have implied quotes, Pro Rata order matching and have highly correlated nature. Yet the major theme of transition remains the same. As a result, most big players on the street

are producing suites of advanced execution algorithms in some form. Barclay's BARX, Credit Suisse's Prime Trade (Onyx), Deutsche Bank's AutoBahn, Goldman's REDI MAST , BlackRock's Alladin, Quantitative Brokers's algo platform and many more. Some are pure agency business model, some are focused on internalizing client flow and some for the Prime services business. Naturally, Algorithmic Trading now accounts for 45% of overall trading in U.S. Treasuries over ICAP's BTec platform alone.

Spread Trading Algorithms

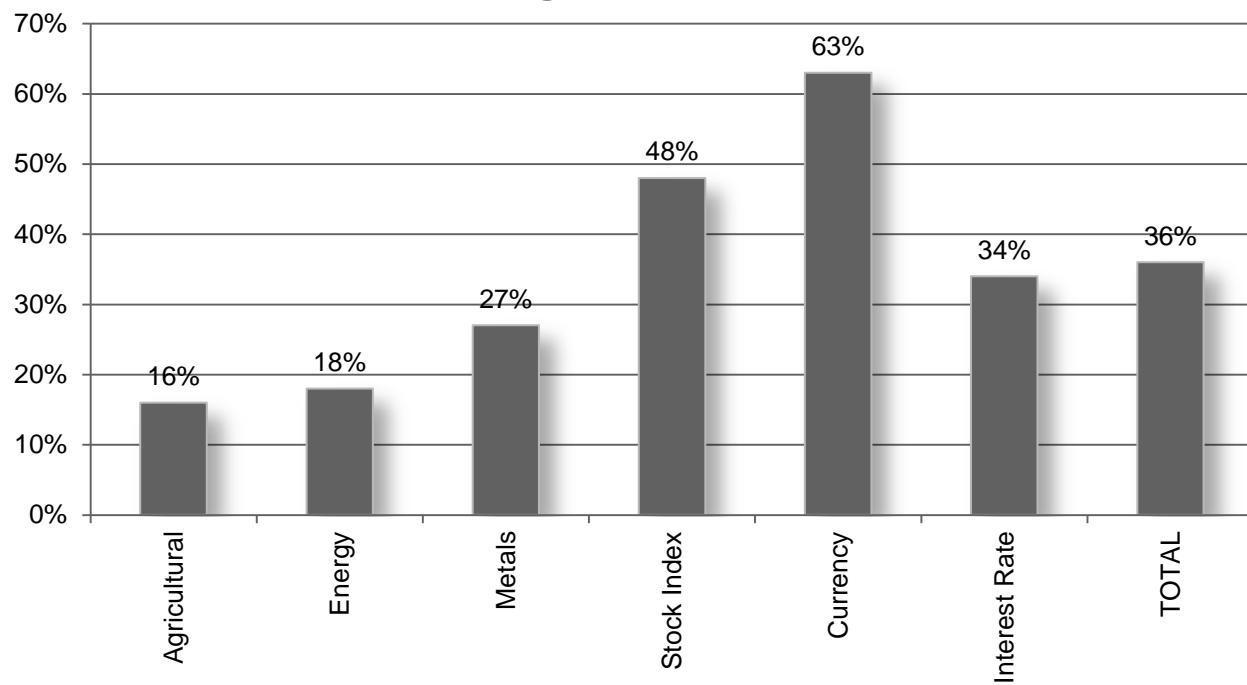
Algorithmic trading provides significant advantage in trading spreads. Rates spreading algorithms target on achieving a VWAP spread among Treasury cash and Futures to take advantage of their Relative Value movements with respect to the yield curve.

Traditionally, it was

worked manually. However the evolution of technology and continuous progress made by exchanges has enabled computers to take over this task very efficiently.

Today almost all the brokers and dealers on the street have some flavor of spread execution algorithms. These algorithms are used for

% Volume of Algo on CME, 2010



Volume traded at CME in April 2010

Automated or algorithmic (algo) trading methodologies have steadily evolved since the time that electronic trading systems have become available – CME Group

executing complex spreads such as mis-weighted Butterfly, solve specific purpose such as rolling future positions and conditional trading based on market levels etc. For past few years, I have been developing execution algorithms for trading interest rates products – T-Notes, T-Bonds, T-Future, Eurodollars. Most recently, I conceptualized a Multi-legger algorithm which allows trading duration neutral and custom combination of above products.

Having such advanced algorithm in rates market in a paramount. Consider you have Cointegration signal to trade four points on the yield curve to take advantage of their relative movement from

long-term levels. This condor trade could be easily done using the algo, which will work through the market movements to get the spread of their levels. Such algorithms are now widely available.

Conceptually, such multi-legger can be further improved to another dimension by including cross products. An algorithm that can trade Multi-Asset Multi-Legged spreads. This will allow traders from various desks to co-ordinate among them and gain competitive advantage, while at the same time, reducing cost of having separate platforms.

Machine Learning

There are algorithms that use historical data along with incoming current market data to generate execution plans. For example a strategy trying to avoid negative price impact will generate an execution plan based on historical data analysis to optimize order placement. It will then scatter the orders over a period to dampen the market impact of overall position desired. There are news driven algorithms as well (as evident from the recent Tweet Crash). These algorithms depend on massive historical data and very fast event analysis. Machine learning is highly effective data mining technique and Artificial intelligence (AI) has many uses in Finance. Today the smartest trading algorithms heavily depend on AI and Machine learning. Such algorithms can process huge amount of data very quickly and continue training online with incoming data for making better decisions. They learn to react to market events, predict the movements and carefully filter out the noise, like the human traders do, but much faster and deterministically as programmed.

In one independent research, I used the high frequency order book data for treasury futures for price discovery process. I discretized the data to frequency of one second and calculated some features. These features included Cross Sectional features such as order imbalance, bid ask pressure etc and Time Series features such as trade imbalance, exponential moving average of weighted mid, number of price increments during last N seconds etc.

I computed various features and selected few, which had most predictive power. I used these features with Support Vector classifier, Logistic regression and one Ensemble classifier (Random Forest) to predict the mid price direction in next M seconds. The study was done using Python Scikit Learn module. In normal market conditions, all three were able to predict the mid price direction very well. This basic model can be improved to incorporate news events, auctions, trending markets and high volatile markets.

Overall, machine learning is highly effective computational technique that is already playing a key role in Trading and its usage will further grow in future.



Like Automated Trading Desk, RGM Advisors, and Renaissance before them, Getco started recruiting AI

programmers skilled in machine-learning techniques. Highly sensitive programs would monitor reams of data coming from all corners of the market, learning dynamically on the fly which strategies worked best under a variety of circumstances. – Dark Pools by Scott Patterson

Renaissance uses computer-based models to predict price changes in easily-traded financial instruments. These models are based on analyzing as much data as can be gathered, then looking for non-random movements to make predictions - Wikipedia

Electronic Market Making

High Frequency Automated Market Making for Fixed Income Products

Algorithmic trading is critical for High frequency market making desks. HFT market making strategies utilize simple and faster inventory models to acquire and liquidate positions frequently to realize small profit but for large number of times. These strategies update orders very frequently and have no overnight positions. For successful edge retention, ultra-low latency connectivity to the exchanges and faster trading and order routing trading algorithms are a must. Machine learning based price discovery algorithms can provide the market makers better predictive power for the fair values in future. All the major broker-dealers are investing heavily in automating their business. The trend will further grow.



Conclusion

Despite the fact that there were recent disasters when machines went uncontrolled, this area is still growing. With the market share of Algorithmic Trading obviously growing, the regulators have been concerned with the reliability and efficiency in the markets. An added influence: Regulations aimed at moving more derivatives trading onto exchanges are seen as compounding the opportunities for electronic trading. But it is important to understand that Algorithmic Trading is way to efficiently trade and not a trading strategy by itself. History has shown that those, who innovate and adapt in the face of change, those who are able to invest and integrate new technology are more likely to come out ahead in long run.

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