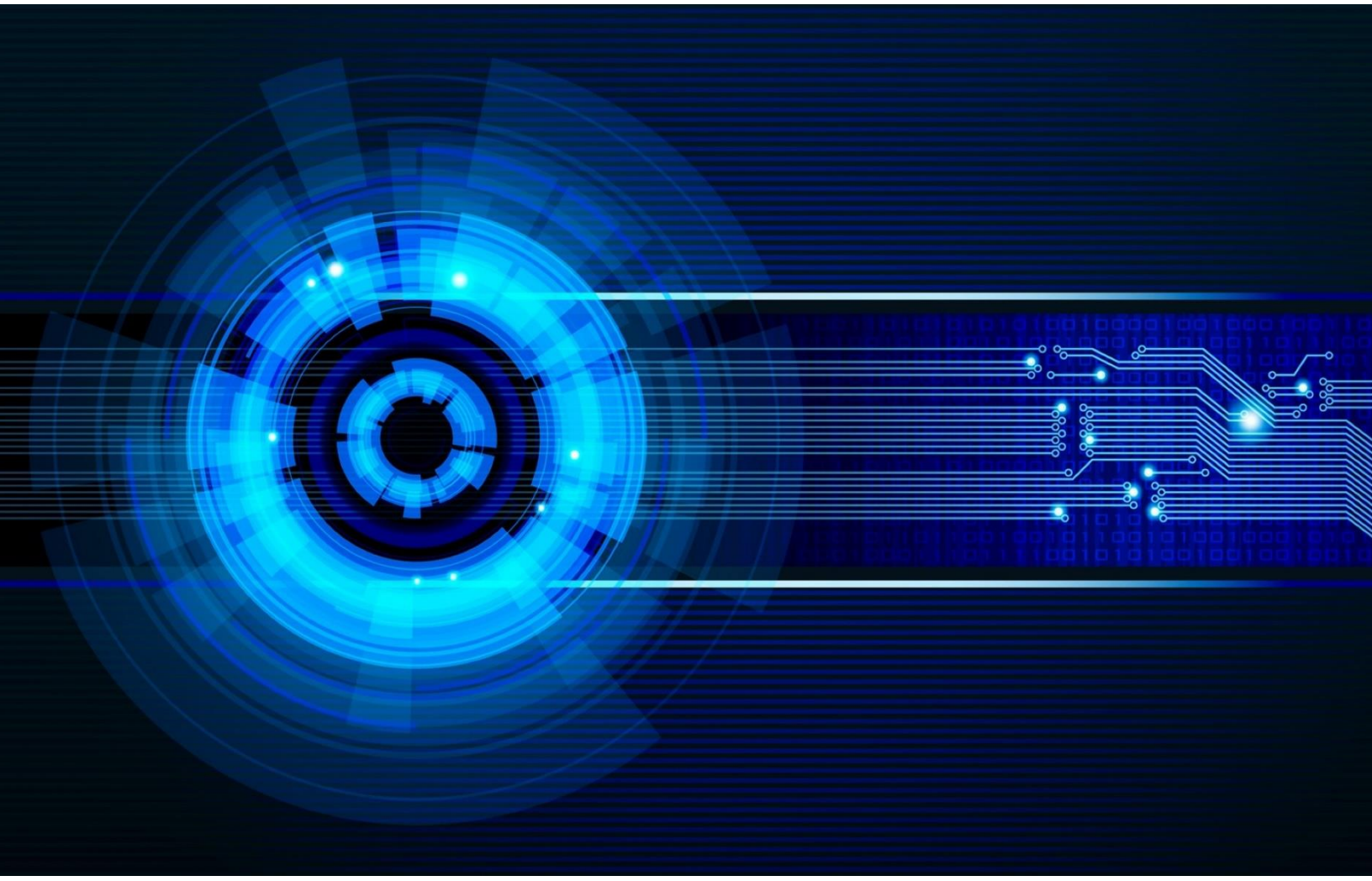
ALPHACUTION

Case Study:

Spot Trading, LLC



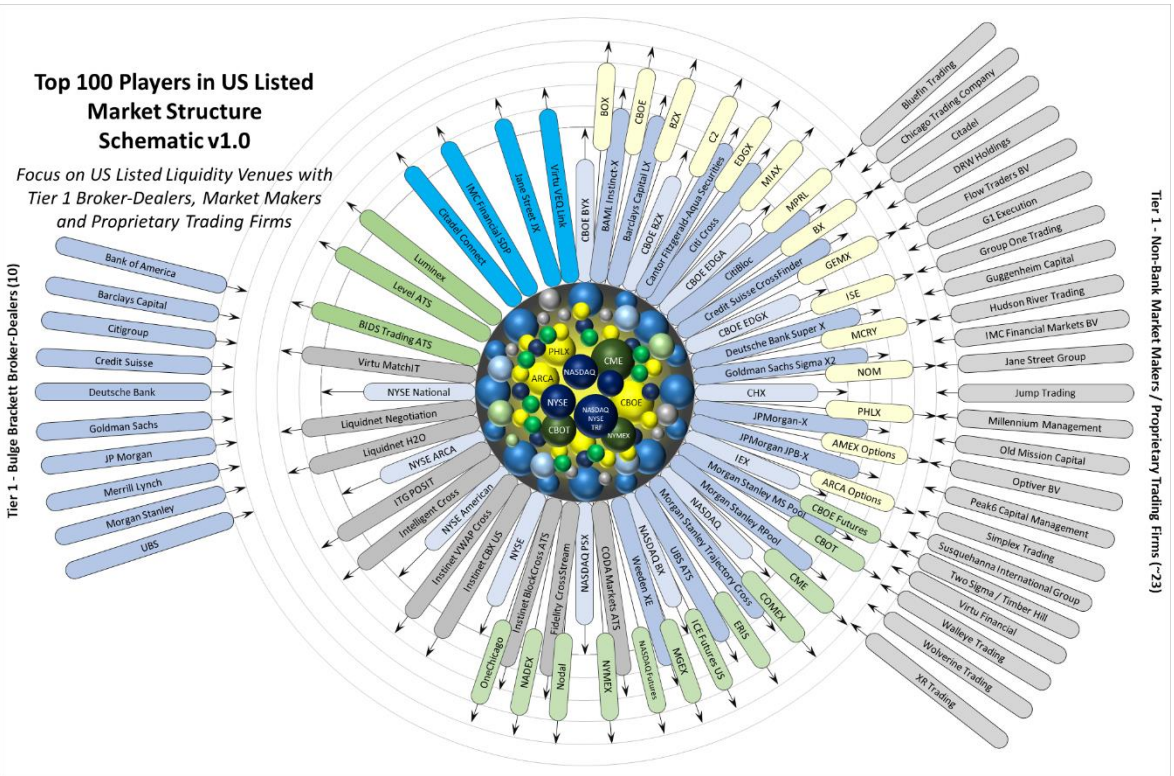
March 2019

OVERVIEW

This document has been developed to support three simple goals: 1) To demonstrate the level of information and insight that can be assembled based on disparate datasets, all of which at this stage are publicly available, 2) To educate our clients and our broader network about the mechanics and drivers of *macro*-market structure, and 3) To provide a template that will begin to set expectations for the nature of premium content that is being made available as part of Alphacution's emerging research subscription service.

Founded in 1999, headquartered in Chicago and specializing in listed equity options, Spot Trading, LLC ("Spot") grew to become one of the premier proprietary trading firms in the US, if not, the world. At its peak in 2014, Spot's gross portfolio value (i.e. – sum of long and short sides) was nearly $7 billion, with 9.2 million in daily average open option contracts, and over 79 million in long cash equity shares. By late in Q4 2017, however, Spot was preparing to close. If it were still in operation, Spot would certainly find itself as part of Alphacution's recently published schematic, "Top 100 Players in US Listed Market Structure," the primary illustration from which can be found in Exhibit A, below:

EXHIBIT A: TOP 100 PLAYERS IN US LISTED MARKET STRUCTURE, SCHEMATIC V1.0



Source: Alphacution, SEC, FINRA, company data

We have chosen to showcase Spot in this sample case study precisely because it no longer represents a live and ongoing trading strategy, and therefore, can better serve as an open example

of what we are building here at Alphacution. Spot is also an ideal sample case because it represents a robust dataset of combined 13F and X17A5 (i.e. – "FOCUS") reports with the SEC that, together, provide the opportunity for more detailed insights than either report form can provide by itself.

Now, before we get into the specifics, it's important to set the stage and help our readers understand the frame within which Spot belongs because their story is representative of many of our priority research targets for this phase of Alphacution's platform development: Those firms that operate closest to the sources of listed liquidity tend to execute the most highly-active strategies, and therefore, tend to bear similar disclosure requirements. This is because broker-dealers (who are required to file a FOCUS report) that are also active enough to be accumulating positions (to the extent that they are required to file a 13F report) tend to be among the largest market makers and proprietary trading firms in the ecosystem that need to minimize the cost of trading.

Alphacution's current assembly of priority buyside research targets that fall into this category – many of which who will be the subject of upcoming reports - can be found below, in Exhibit B:

EXHIBIT B: LEADING BUYSIDE BROKER-DEALERS

Leading Buyside Broker-Dealers Market Makers and Proprietary Trading Firms filing both SEC Form 13F *and* X-17A-5 reports		
Primary		Secondary
Bluefin Trading, LLC	Millennium Management, LLC	Allston Trading, LLC
Chicago Trading Company, LLC (CTC)	Old Mission Capital, LLC	Apex Clearing Corp. (div. - Peak6 Investments, LLC)
Citadel, LLC	Optiver BV	Belvedere Trading, LLC
DRW Holdings, LLC	Peak6 Investments, LLC	CMT Trading, LLC
Flow Traders NV	Simplex Trading, LLC	CSS, LLC
G1 Execution Services, LLC	Susquehanna International Group, LLP	Equitec Proprietary Markets, LLC
Group One Trading, LP	Timber Hill, LLC (div. - Two Sigma Investments, LP)	Quantlab Financial Group
Guggenheim Capital, LLC	Two Sigma Investments, LP	SpiderRock Advisors, LLC
Hudson River Trading, LLC (HRT)	Virtu Financial, LLC	Spot Trading, LLC (closed Jan 2018)
IMC Financial Markets BV	Walleye Trading, LLC	Summit Securities Group, LLC
Jane Street Group, LLC	Wolverine Trading, LLC	TradeLink, LLC
Jump Trading, LLC	XR Trading, LLC	

Source: Alphacution, SEC, FINRA, company data

While each of the aforementioned players – and others emerging and decaying around the periphery of this group - is going to have its own unique strategy, dataset and story for how it came to be wherever it is, Alphacution believes that all these players operate within the same segment of the trading and asset management ecosystem. We have given a name to this segment: *Structural Alpha Zone*.

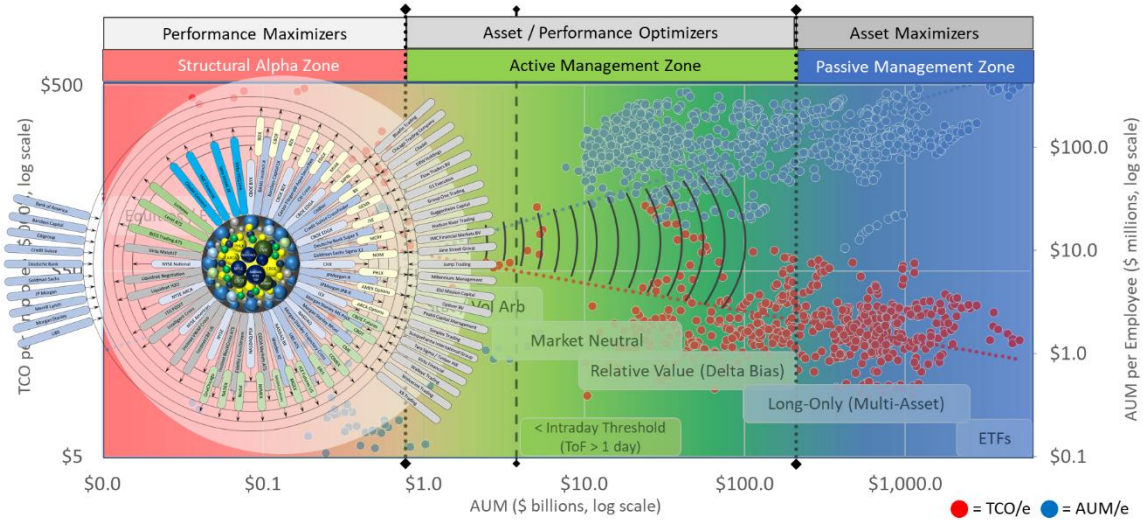
This zone is part of a broader ecosystem hypothesis first validated in our report, "The Context Machine: Estimating Asset Manager Technology Spending," wherein technology investments, level of workflow automation, and strategy selections are all correlated. This work has also led to a corollary hypothesis that the *capacity of alpha* is finite, albeit elastic, as well.

Alphacution's focus on the collection of leading market makers and proprietary trading firms is born out of this central idea:

> *If the capacity of alpha is finite, and a subset of leading market makers and proprietary trading firms (and select quantitative hedge funds) are capturing more of that finite alpha by deploying increasingly automated and sophisticated trading engines, then what happens to the declining residual capacity of alpha in the neighboring active and passive management zones?*

Alphacution expects that many market actors and their stakeholders are going to be interested in the answers to these and similar questions. Though at first glance it will appear complex, the following illustration is a visual metaphor for the data-driven model that Alphacution is developing to quantify these phenomena.

EXHIBIT C: ASSET MANAGEMENT ECOSYSTEM MAP WITH LISTED LIQUIDITY SCHEMATIC



Source: Alphacution, SEC, FINRA, company data

With these ideas as backdrop, the following is Alphacution's interpretation of select findings about Spot's trading and, by implication, business strategies. These findings are based solely on experience and the data found in the total sample of 28 quarterly 13F reports for the time range December 31, 2010 to September 30, 2017 and 16 annual FOCUS (X17A5) reports for the years ending 2001 thru 2016 filed by Spot Trading, LLC and related entities with the US Securities and Exchange Commission (SEC). No representative of Alphacution has spoken to any representative of the former Spot Trading entities for the preparation of this report.

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TABLE OF EXHIBITS

SELECT FINDINGS

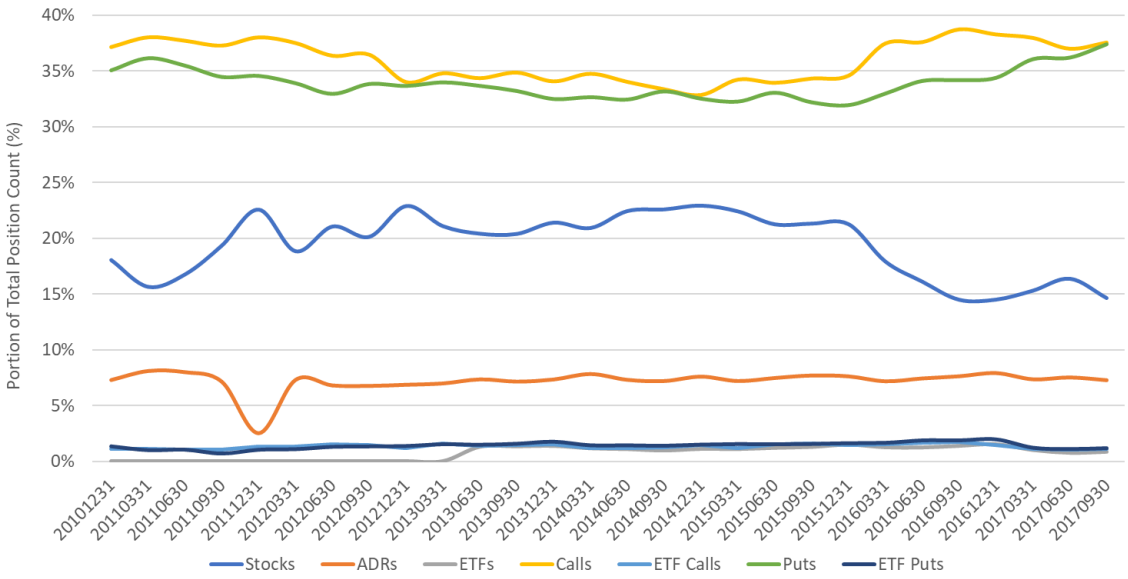
The following vignettes are based on the full sample of 35 charts and illustrations contained within the Exhibit Library section of this report. In some cases, specific exhibits will be referenced by number. In other cases, specific exhibits will be duplicated and labeled with letters within the relevant section. Also note that certain charts with volatility overlays have been presented without a scale. These overlays are intended solely to indicate spikes or lack of spikes in volatility that may or may not correspond with Spot's portfolio data.

STRATEGY AND PORTFOLIO BASICS

At its peak in mid-2014, Spot was reporting over 4,500 positions in its 13F filings, which it must be reminded was only the long – or, more precisely, the "owned" - side of the overall trading book. Still, for the 28 quarters when Spot filed 13F reports, total position count was always greater than ~2,700. This is consistent with most other leading option trading firms; they tend to hold and manage more positions than any other type of trading firm.

Below the top line position count, product segmentation logically favored equities and equity options. With put and call positions (and values) always moving in some level of lockstep, roughly 35% of positions (and ~40% of value) was typically allocated to each. US equities typically comprised about 20% of positions and a very consistent ~7% of positions was allocated to American depository receipts (ADRs), or foreign companies listed in the US. Exchange traded products (ETPs / ETFs) never became an important component of Spot's trading strategies, see Exhibit D, below:

EXHIBIT D: PERCENTAGE OF POSITIONS BY PRODUCT CLASS, Q4 2010 – Q3 2017



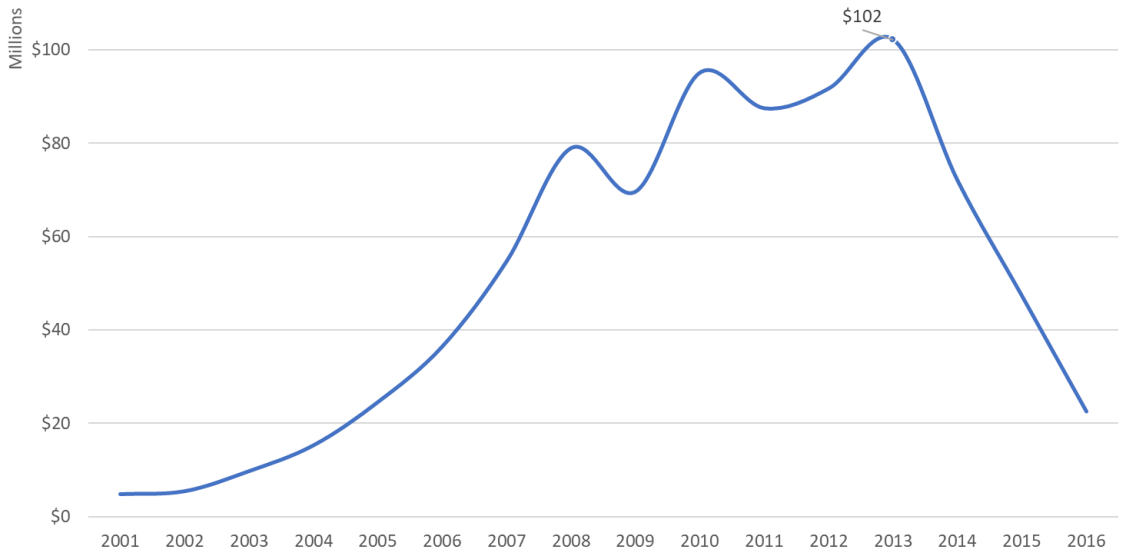
Source: Alphacution, SEC

However, even though there was typically three times the number of positions in straight US equities relative to ADRs, both categories tended to represent similar aggregate values (see Exhibits 5 and 12) thereby illuminating the favorable opportunities in ADRs. Exhibit 15 supports this point with the illustration of the variance in average position size.

Though Spot's portfolio – and profitability - continued to grow until 2014, the core strategy – namely, the dynamics of position count and portfolio segmentation - tended to remain relatively consistent for the duration. Yes, there had been a couple hiccups in the recent past, but something different – a new trajectory – seemed to emerge in 2014 that persisted until the decision to close.

Was this new trajectory caused - directly or indirectly - by a new post-GFC volatility regime? Did a fateful tweak of strategy lead to a snowball effect of unwinding? Or, did Spot simply scale beyond the inherent wheelhouse of their core strategy? A time series of member's equity from near-beginning to near-end – though not a guaranteed proxy for profitability – at least tells a story about the journey that happened here:

EXHIBIT E: SPOT TRADING, LLC - MEMBER'S EQUITY, 2001-2016



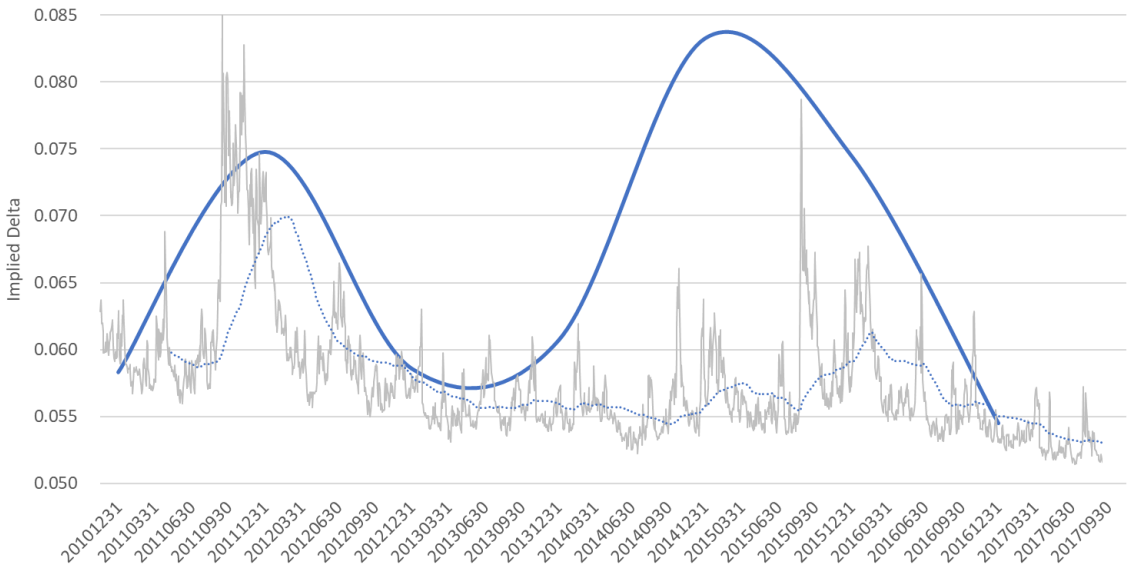
Source: Alphacution, SEC

ESTIMATING IMPLIED DELTAS

Option positions tend to cause illusions for 13F report analysis because they are disclosed at the cash-equivalent of 100 delta. In practice, options are never 100 delta until exercised. Therefore, the 13F "portfolio value" – which is the gross notional long market value of 13F securities owned by the reporting firm – for trading firms that hold a lot of options positions are always highly inflated.

The FOCUS report brings this inflation into perspective because it discloses fair market values of all underlying securities, including options. So, when we compare the 13F option values with that of the FOCUS report, we get the variance ratio between notional and actual values. In the case of Spot, that variance ratio tended to average 5.3:1 for the period 2010 to 2016. The inverse of this variance ratio is the *average implied delta* of the long options book, see below:

EXHIBIT F: EST. IMPLIED AVG. LONG DELTAS W/ REALIZED S&P500 VOLATILITY OVERLAY, Q4 2010 – Q3 2017



Source: Alphacution, SEC

Now, why does a book of long options that average 5.5% – 8.5% probability of being in-the-money make sense for a firm like Spot? The business of option market making means selling – as in, being short - a lot of at-the-money (ATM) options because that's what customers want to own. Customers want to be long puts and calls, in most cases.

To hedge short ATM risks, market makers typically go long a lot of "wings," or out-of-the-money (OTM) options. Since the 13F reports only show the long side of an option market makers book, it will therefore only show low-delta, OTM options. Plus, this rationale is supported by the change in average implied delta roughly corresponding to the overlay of realized S&P500 volatility.

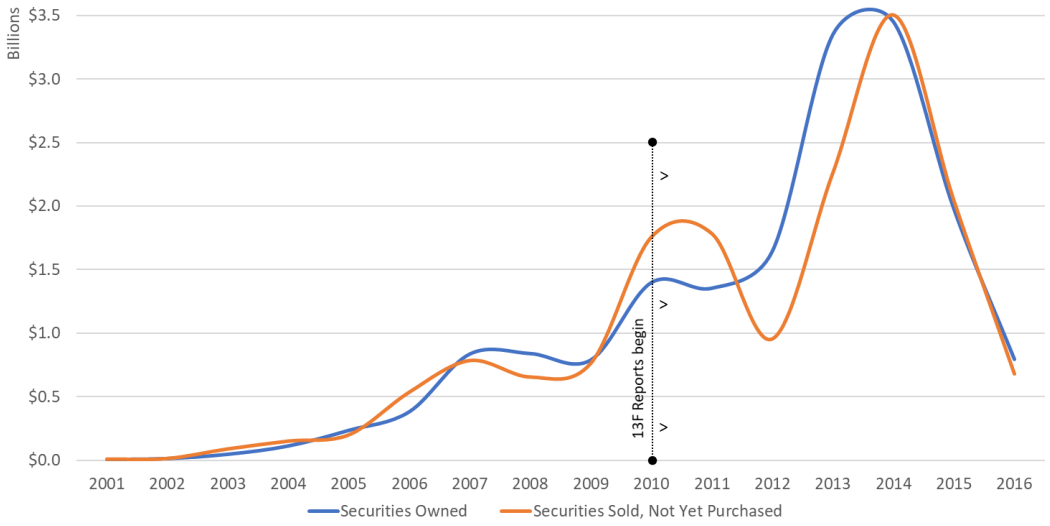
This is a fascinating discovery from the data that could only have been made possible with combined insights from both 13F and FOCUS reports.

WHAT HAPPENED TO SPOT TRADING?

We may never know the real answer to this question - *What happened to Spot Trading?* - but there is ample evidence and numerous clues to chew on from the available data and our own modeling. We suspect that the first major drawdown in profitability that occurred sometime in 2014 (recall

Exhibit E related to Member's Equity) corresponded to the peak in the scale of the trading operation, as detailed by peaks in position count and portfolio value in Q2 2014 (see Exhibit G, below).

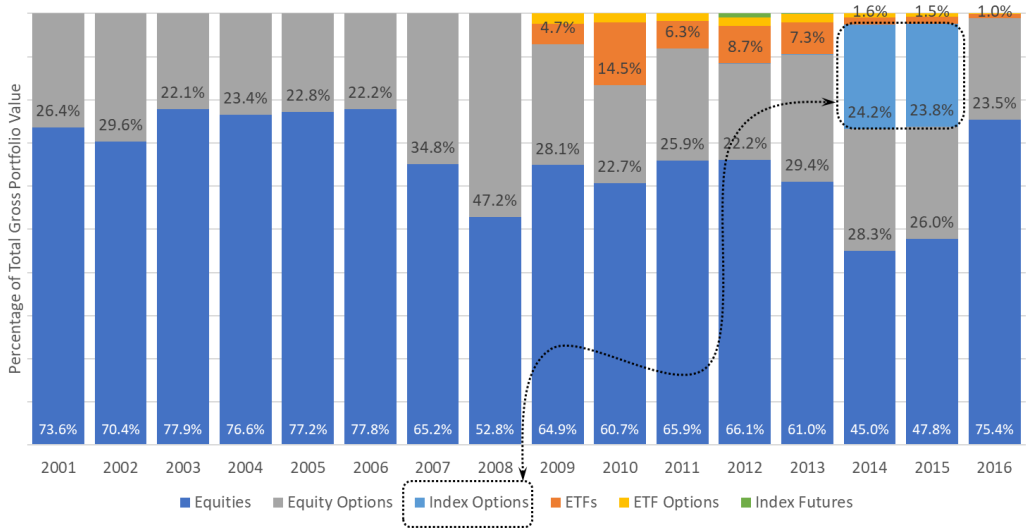
EXHIBIT G: TOTAL PORTFOLIO EXPOSURES BY SECURITIES OWNED AND SOLD (NOT YET PURCHASED), 2001-2016



Source: Alphacution, SEC

Declines in position count and portfolio value thereafter, beginning in Q3 2014 (see Exhibit 1, for example), isolate and provide additional support for this timing as the likely turning point. When we add a notable tweak to the core strategy with the massive and unprecedented index option positioning that shows up in 2014, perhaps we have discovered another source of corroborating evidence (see Exhibit H, below).

EXHIBIT H: PORTFOLIO SEGMENTATION BY PRODUCT CLASS, % OF TOTAL GROSS PORTFOLIO VALUE, 2001-2016

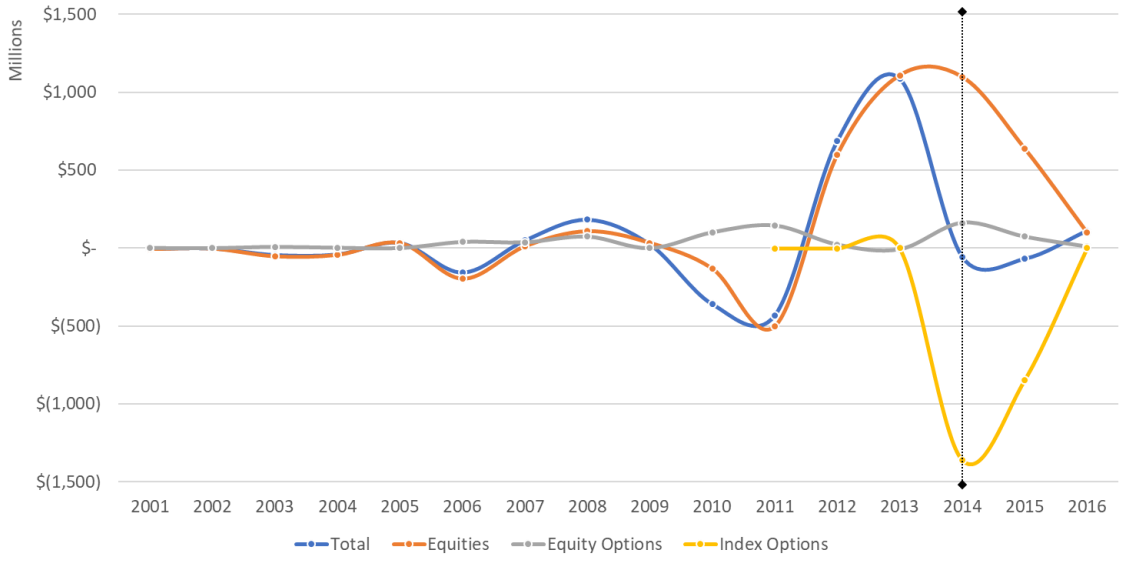


Source: Alphacution, SEC

Why is there a more than 24% allocation of gross portfolio value allocated to index options in 2014? Chances are that it wasn't a new sub-strategy suddenly bolted onto the core strategy because the index option exposures where severely unhedged to lean heavily short, at least on a dollar-neutrality basis. No, the index option positioning was intended to *be the hedge*…

The overall book had scaled to the point where Spot was over-weighted long equities (+35.0%). The option book had always been managed tightly, with an average dollar-tilt of 7.7% over the period 2010 – 2016. To compensate for the big positive tilt in equities, an over-weighted short index option position (-80.8%) was initiated to balance the total portfolio (the blue line in Exhibit I, below) to a near total dollar neutrality position (-0.8%).

EXHIBIT I: NET DOLLAR VALUE BY CORE PRODUCT CLASSES, 2001-2016

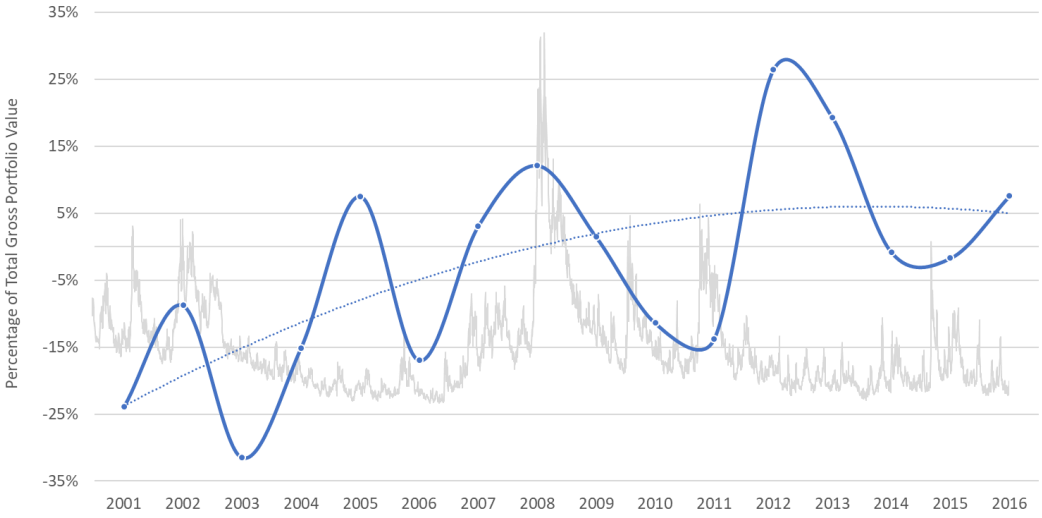


Source: Alphacution, SEC

Furthermore, consider that in 2014 ETFs were not nearly the tool of significant portfolio allocations like they are today – so the unprecedented move to index options might have been handled differently (with more focus on ETFs) in the current environment. Also, consider that after a nearly two year upward march of equity markets in 2013 and much of 2014 with low and barely breezy volatility, October 2014 brought a spike in volatility that doubled the VIX from a sleepy Monday low of 14.05 to a spicy high of 31.05 the following Wednesday. Based on this, one might guess that the beginning of the end at Spot was born on Wednesday, October 15th, 2014.

Even small mispositioning at such scale can have dramatic impacts and long-range reverberations. On the other hand, perhaps a portfolio shock like this was inevitable given what Alphacution originally discovered as the long-term trajectory of portfolio dollar neutrality oscillating from a short bias to a long bias over the full 16-year period beginning in 2001, see Exhibit J, below:

EXHIBIT J: PORTFOLIO DOLLAR NEUTRALITY AS % OF GROSS PORTFOLIO VALUE W/ VIX OVERLAY, 2001-2016



Source: Alphacution, SEC

For this chart, we are taking the ratio of net dollar exposure to the gross *(long vol + short vol)* value of the portfolio over the reporting period. And, it is here that we may have found the evidence that is lying in wait for the right mismatching of volatility and positioning.

The consistent oscillation in the level of short vol positioning to long vol positioning follows a trendline that does not appear to correspond to changes in underlying volatility (as illustrated by CBOE's Volatility Index - VIX). Chances are from what we can see here that Spot's portfolio construction (as it scaled) was not matched up well with the eventual shifts in volatility. They were likely long vol when it was muted, and flat vol when it spiked.

In late 2014, Spot suffered its first major hit to profitability since its founding 14 or 15 years prior. Naturally, this may have caused some “shooting from the hip” (like unprecedented index option positions) which may have further exacerbated the challenges. With consistently – punishingly! – low volatility that came in 2017, it is no wonder that the path to Spot’s recuperation finally went dark.

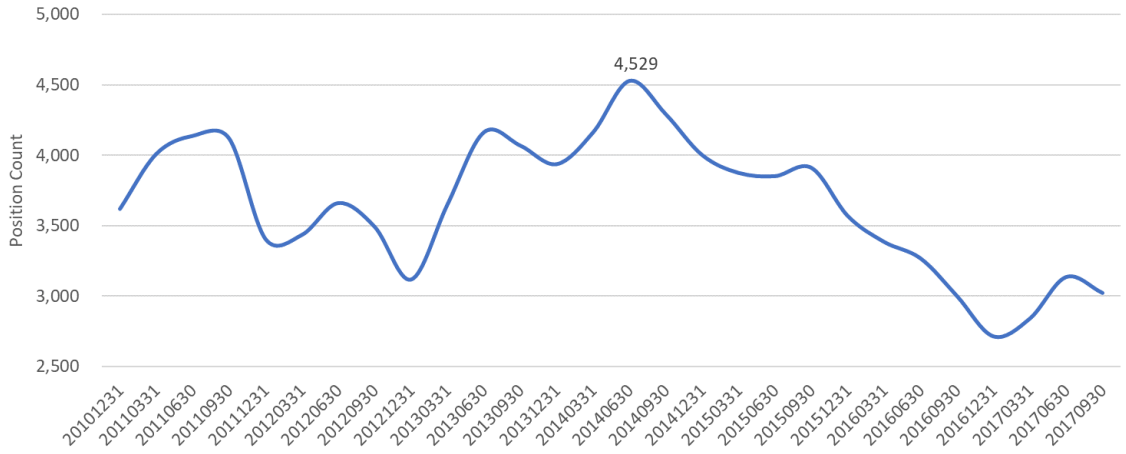
Lastly, we typically assign success or failure in trading to an accurate or inaccurate interpretation of market factors. Market actors typically don’t possess a basis to assign at least a part of their success or failure to an interpretation of competitive forces. Of course, this dynamic changed a few years ago for those players dependent on speed. It became clear that faster players were consuming the alpha of slower players.

Alphacution is not making the claim that Spot succumbed to competitive forces, in whole or in part, here. In time, and with further modeling development, we may be able to circle back and add that factor to the list challenges.

EXHIBIT LIBRARY

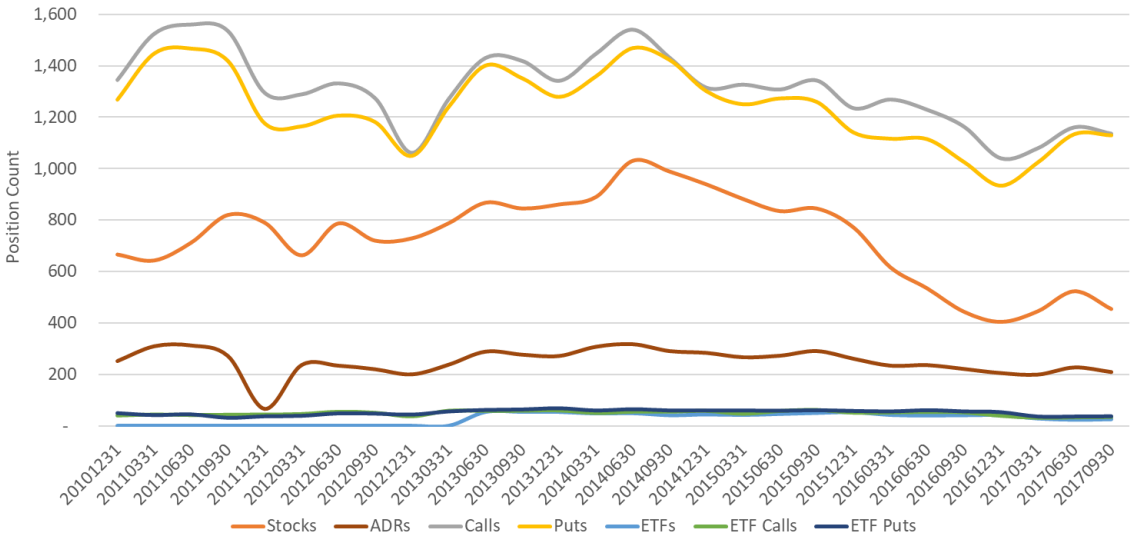
The following exhibits have been developed from the total sample of 28 13F reports for the time range December 31, 2010 to September 30, 2017 and 16 FOCUS (X17A5) reports for the years ending 2001 thru 2016 filed by Spot Trading, LLC and related entities with the US Securities and Exchange Commission (SEC).

EXHIBIT 1: TOTAL POSITIONS, Q4 2010 – Q3 2017



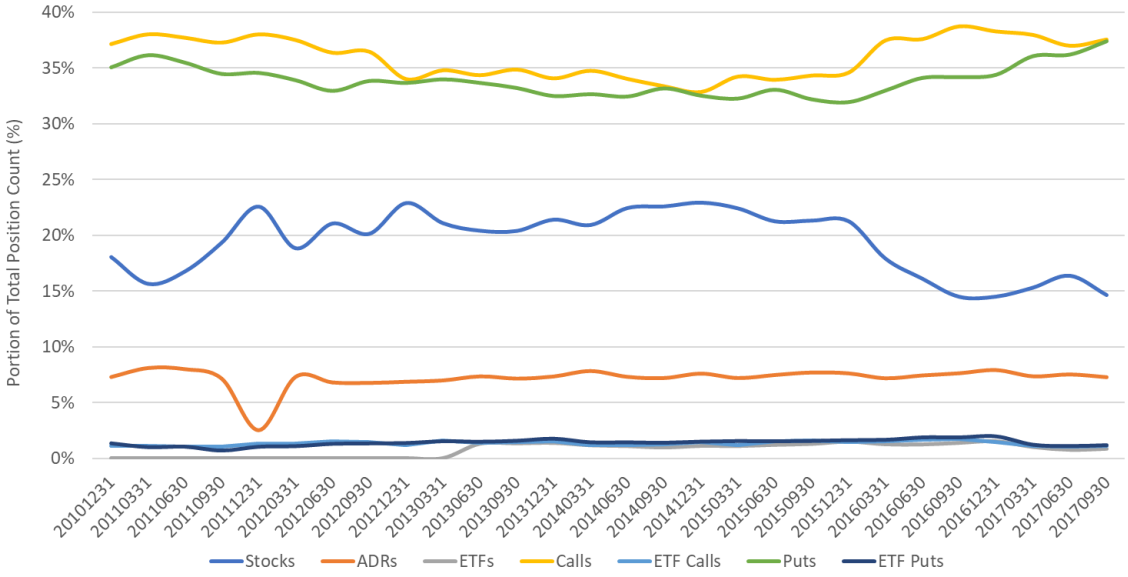
Source: Alphacution, SEC

EXHIBIT 2: POSITION COUNT BY PRODUCT CLASS, Q4 2010 – Q3 2017



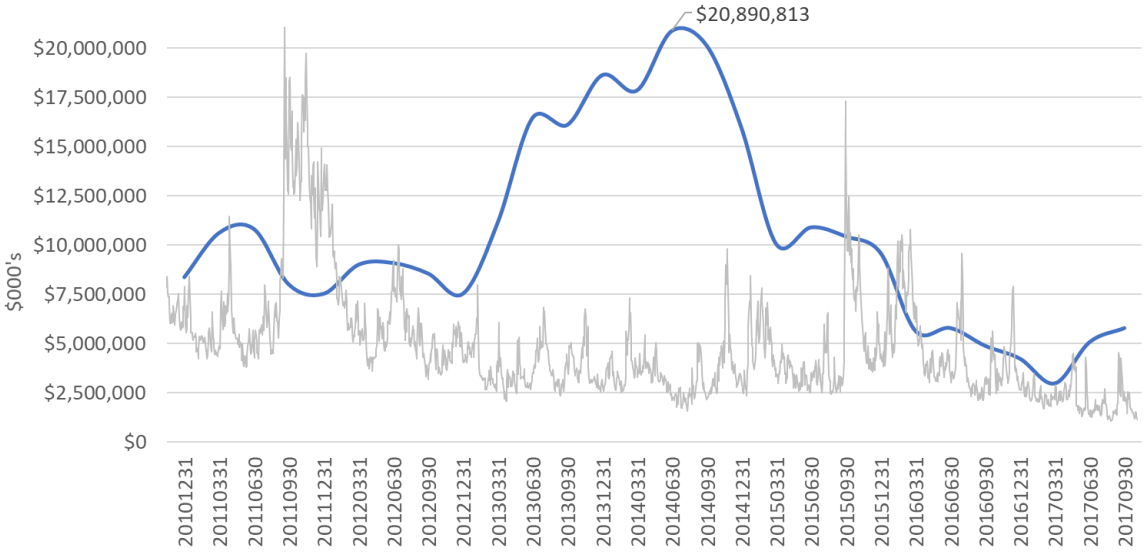
Source: Alphacution, SEC

EXHIBIT 3: PERCENTAGE OF POSITIONS BY PRODUCT CLASS, Q4 2010 – Q3 2017



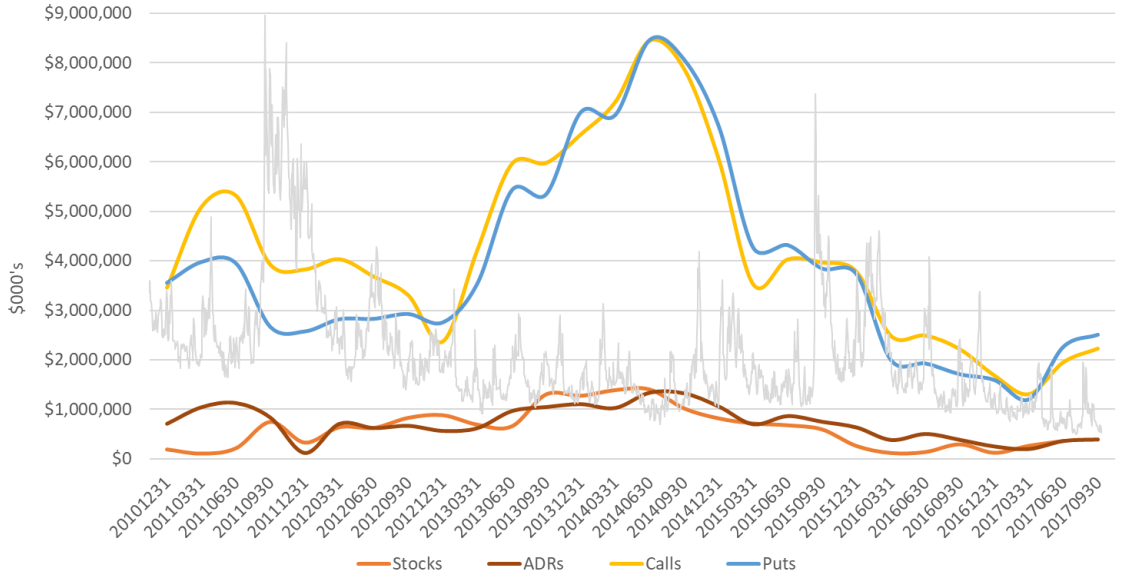
Source: Alphacution, SEC

EXHIBIT 4: TOTAL NOTIONAL LONG MARKET VALUE W/ REALIZED VOLATILITY OVERLAY, Q4 2010 – Q3 2017



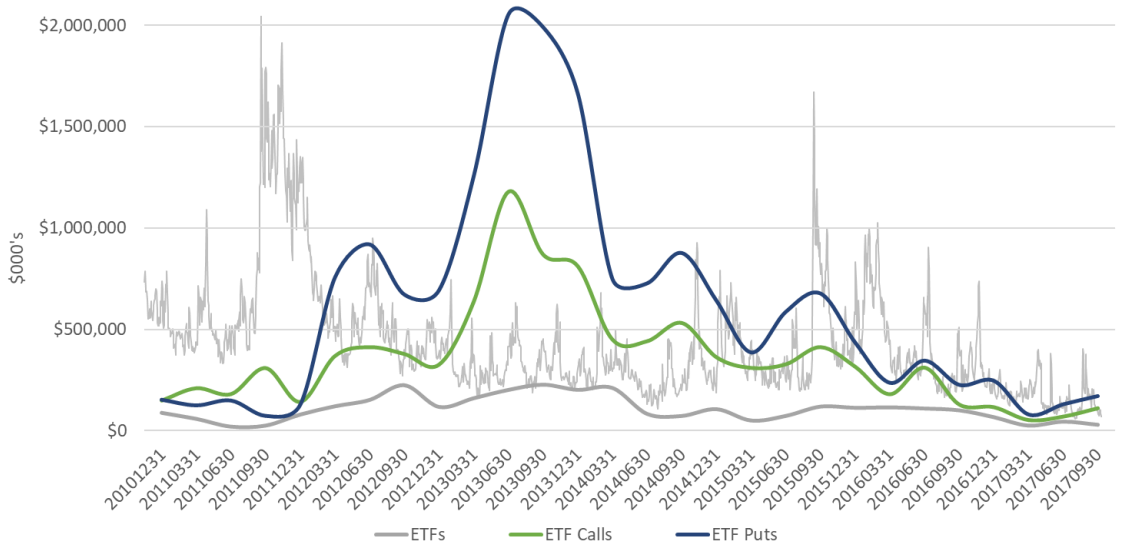
Source: Alphacution, SEC

EXHIBIT 5: NOTIONAL LONG MARKET VALUE BY PRODUCT CLASS W/ REALIZED VOLATILITY OVERLAY, Q4 2010 – Q3 2017



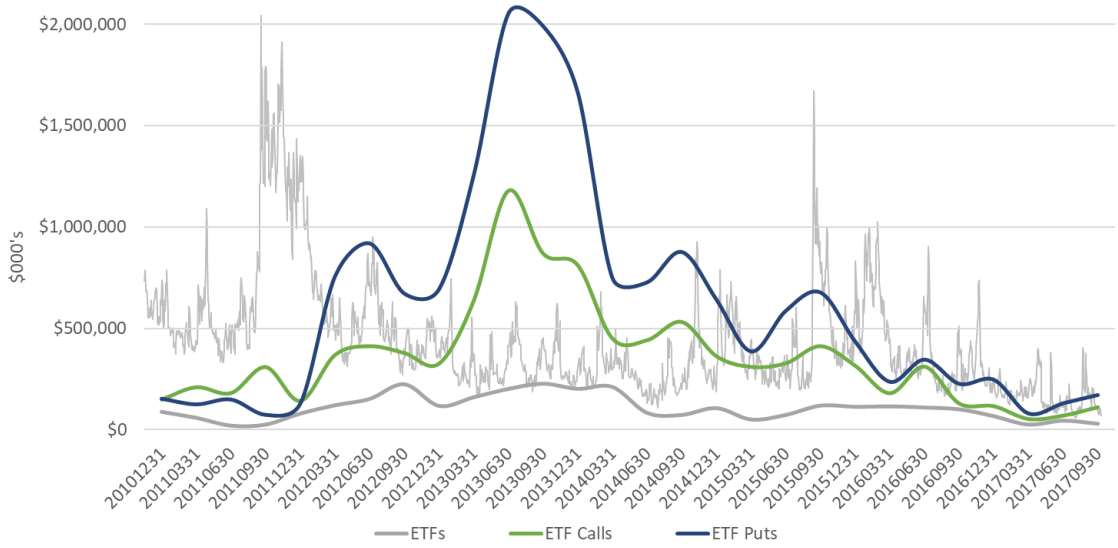
Source: Alphacution, SEC

EXHIBIT 6: NOTIONAL LONG MARKET VALUE BY ETF FOCUS W/ REALIZED VOLATILITY OVERLAY, Q4 2010 – Q3 2017



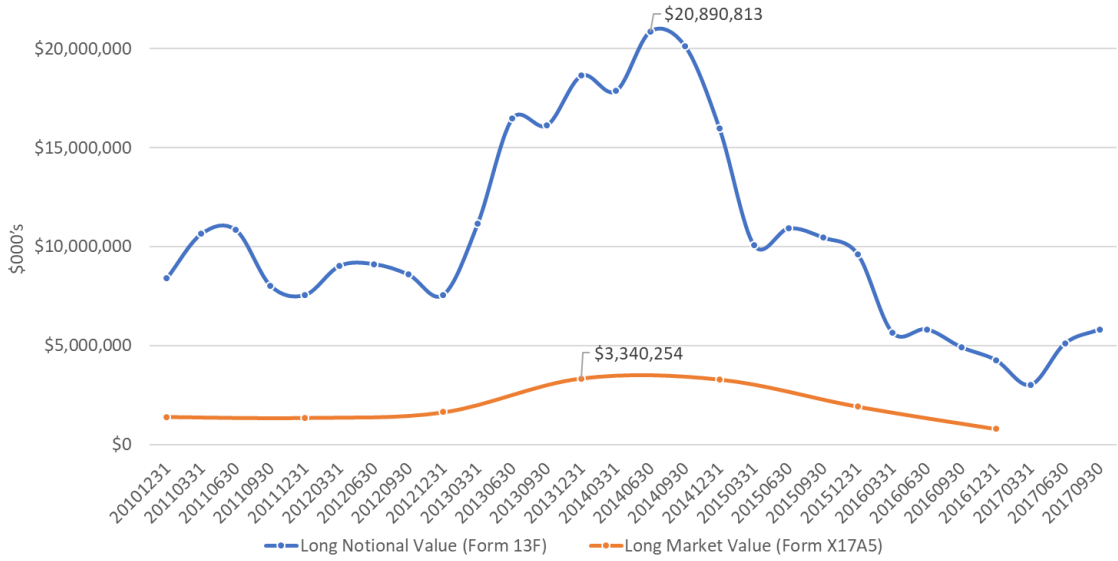
Source: Alphacution, SEC

EXHIBIT 7: NOTIONAL LONG MARKET VALUE BY ETF FOCUS W/ REALIZED VOLATILITY OVERLAY, Q4 10 – Q3 17



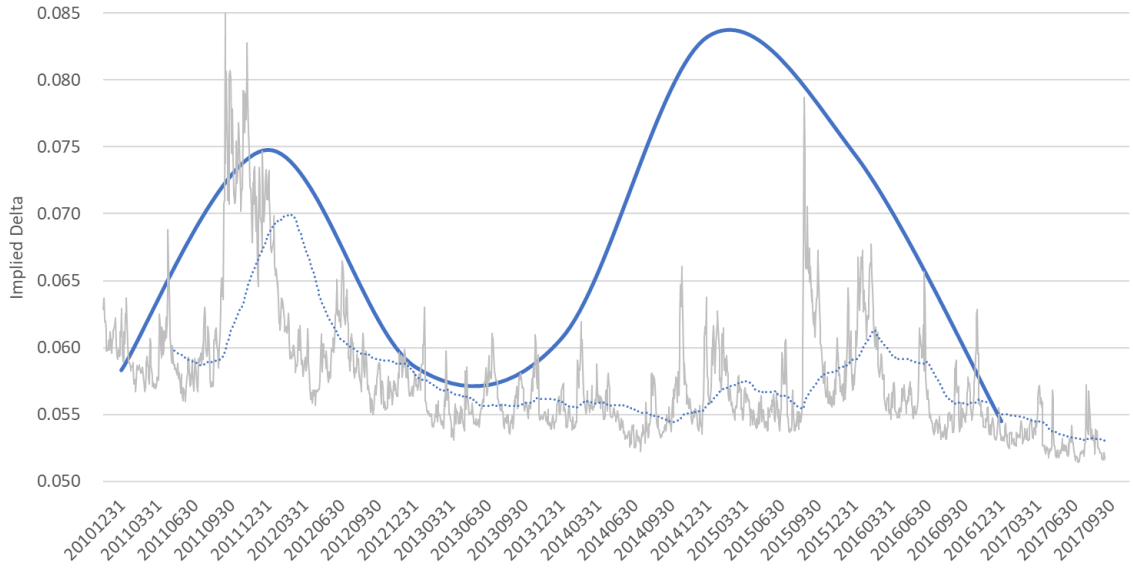
Source: Alphacution, SEC

EXHIBIT 8: COMBINED 13F/X17A5 ANALYSIS - COMPARISON OF LONG NOTIONAL AND FAIR MARKET VALUES, Q4 2010 – Q3 2017



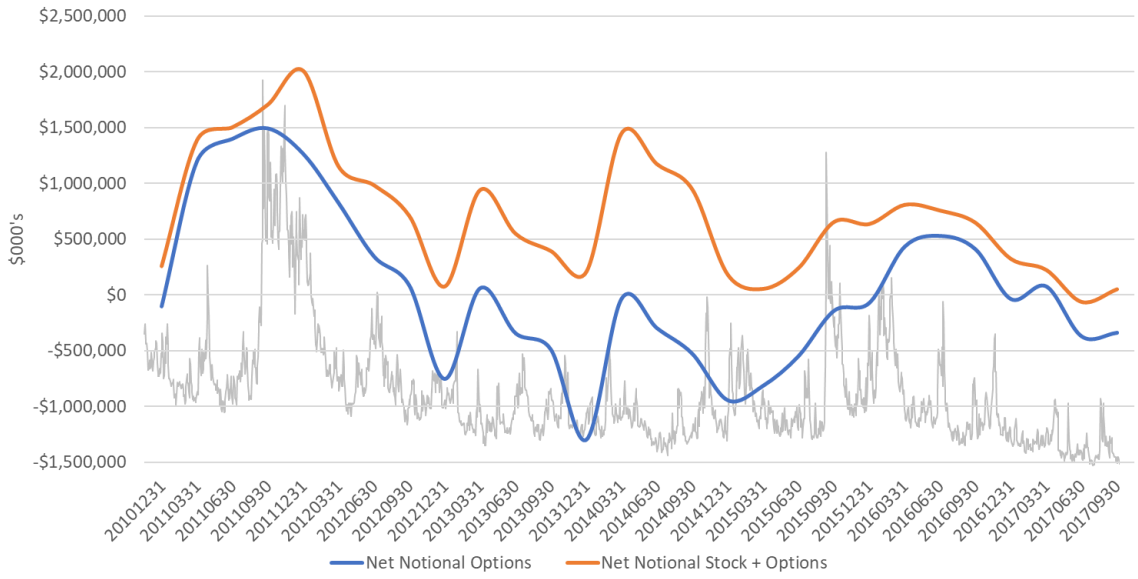
Source: Alphacution, SEC

EXHIBIT 9: ESTIMATED IMPLIED AVG. LONG DELTAS W/ REALIZED SP500 VOLATILITY OVERLAY, Q4 2010 – Q3 2017



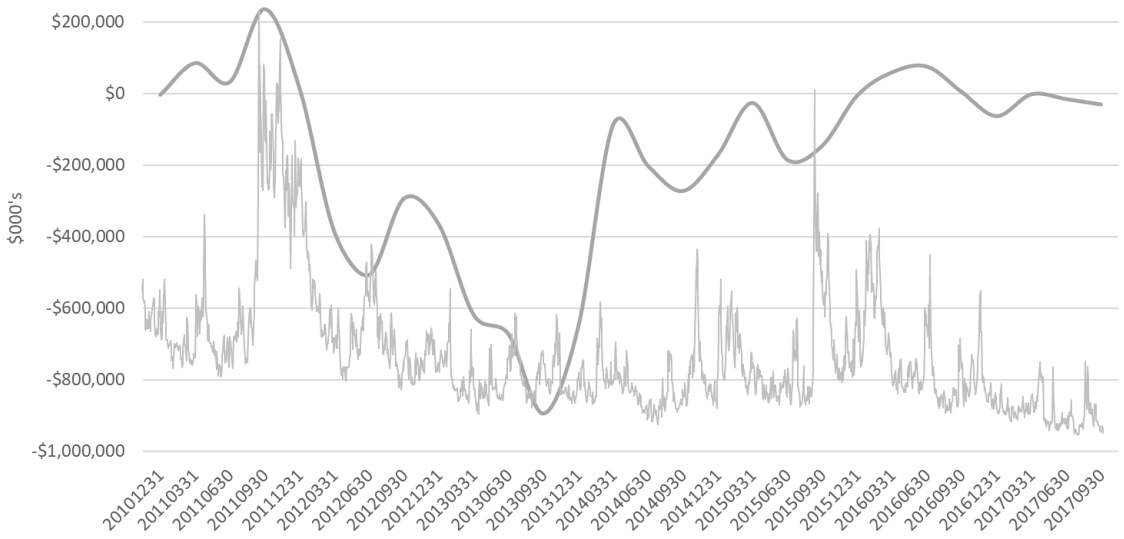
Source: Alphacution, SEC

EXHIBIT 10: NET NOTIONAL (13F) VALUES W/ REALIZED SP500 VOLATILITY OVERLAY, Q4 2010 – Q3 2017



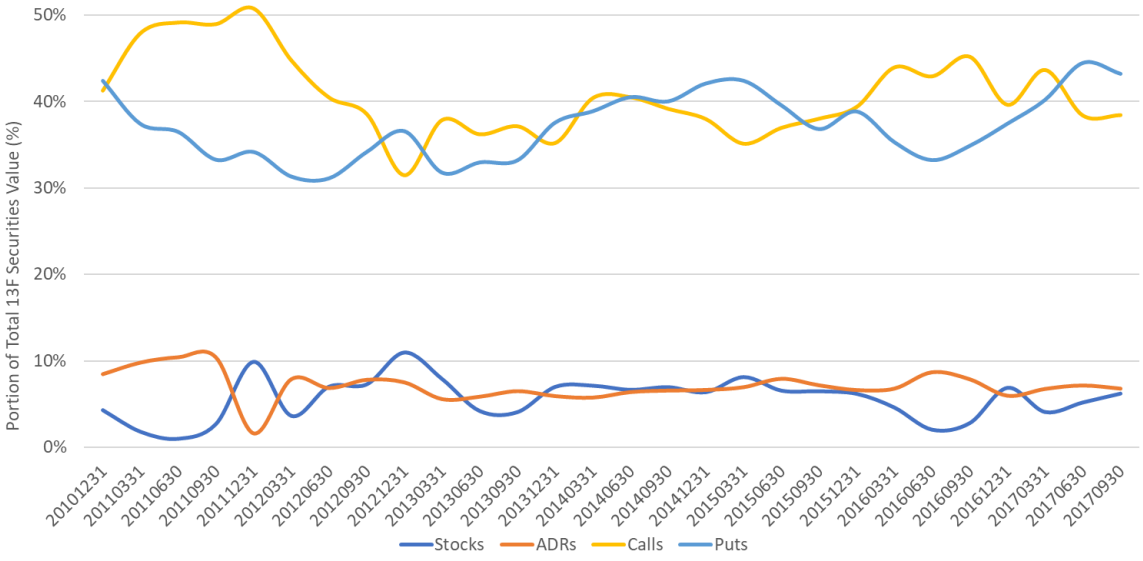
Source: Alphacution, SEC

EXHIBIT 11: NET NOTIONAL ETF VALUES W/ REALIZED SP500 VOLATILITY OVERLAY, Q4 2010 – Q3 2017



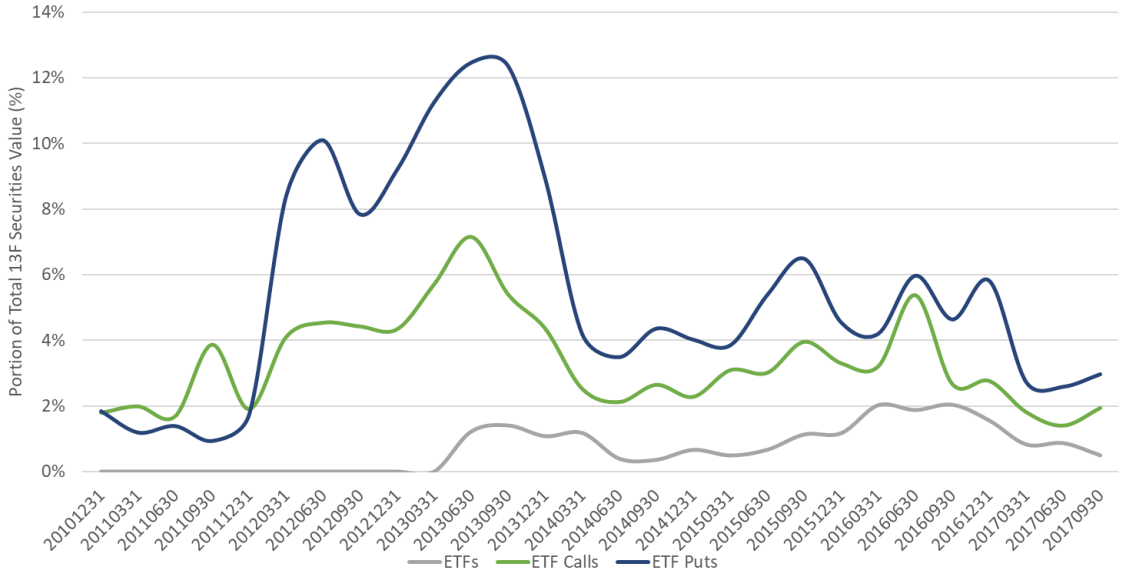
Source: Alphacution, SEC

EXHIBIT 12: TOTAL 13F VALUE SEGMENTATION BY PRODUCT CLASS, Q4 2010 – Q3 2017



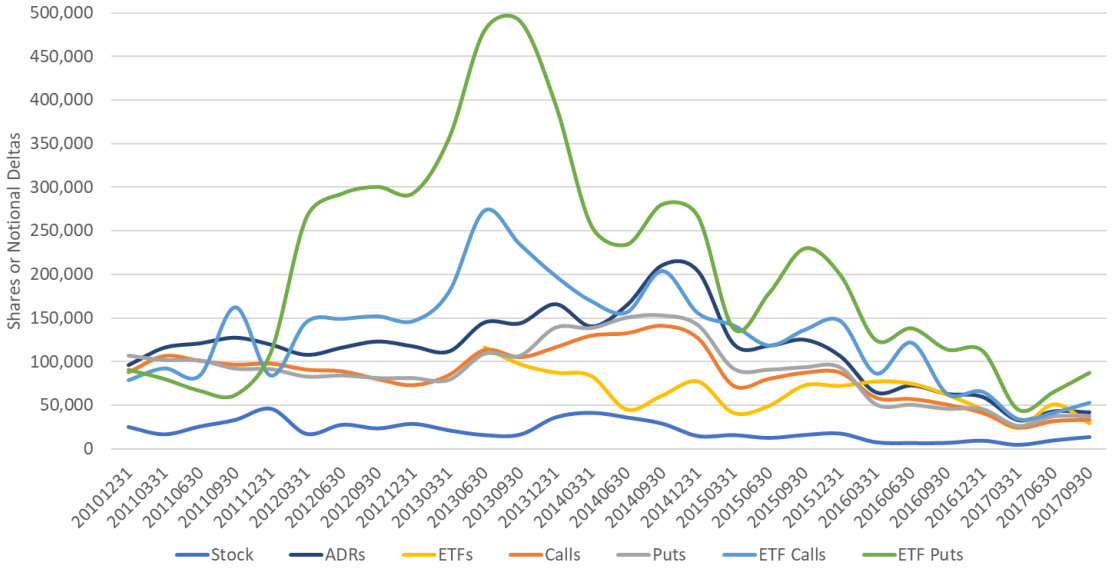
Source: Alphacution, SEC

EXHIBIT 13: ETF VALUE SEGMENTATION BY PRODUCT CLASS, Q4 2010 – Q3 2017



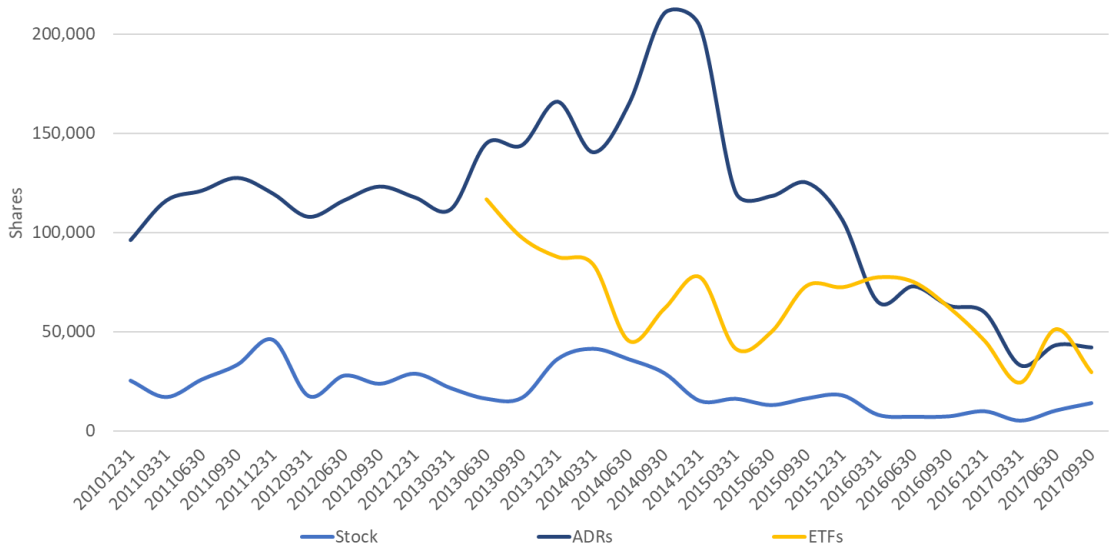
Source: Alphacution, SEC

EXHIBIT 14: AVERAGE POSITION SIZE IN SHARES OR NOTIONAL DELTAS, Q4 2010 – Q3 2017



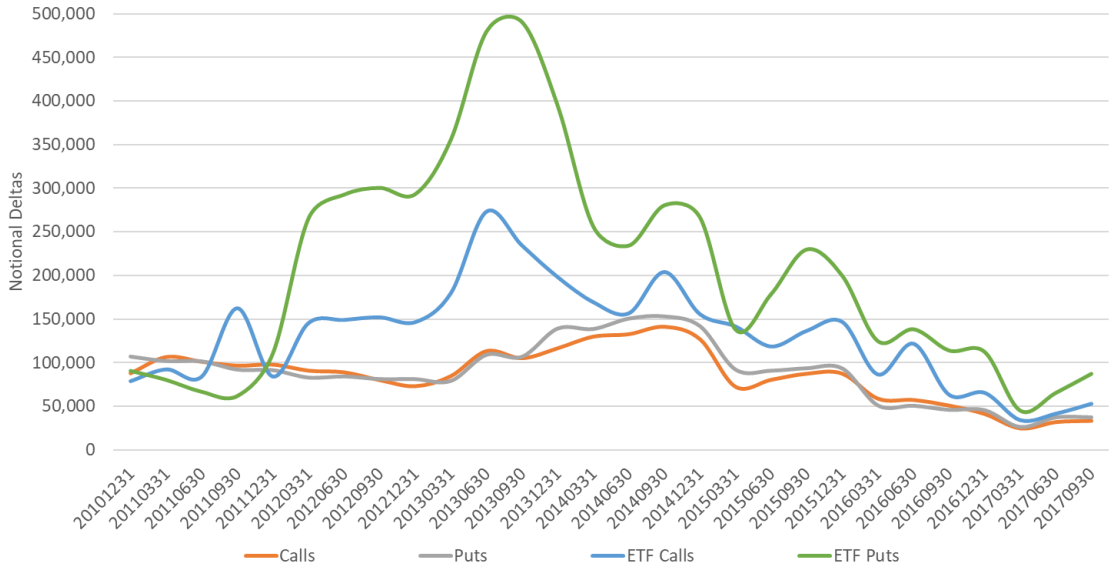
Source: Alphacution, SEC

EXHIBIT 15: AVERAGE UNDERLYING POSITION SIZE IN SHARES, Q4 2010 – Q3 2017



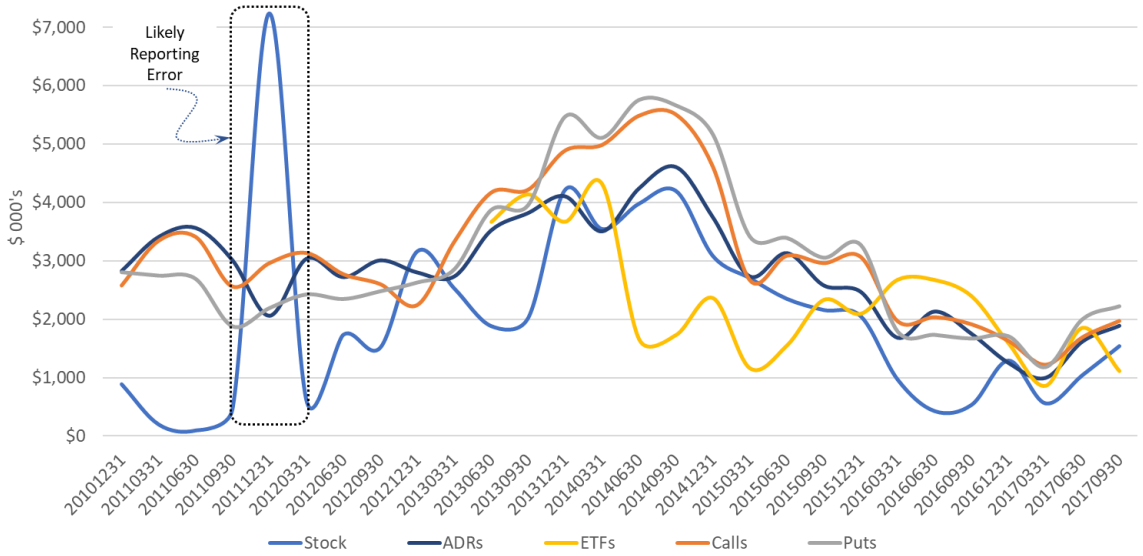
Source: Alphacution, SEC

EXHIBIT 16: AVERAGE DERIVATIVES POSITION SIZE IN NOTIONAL DELTAS, Q4 2010 – Q3 2017



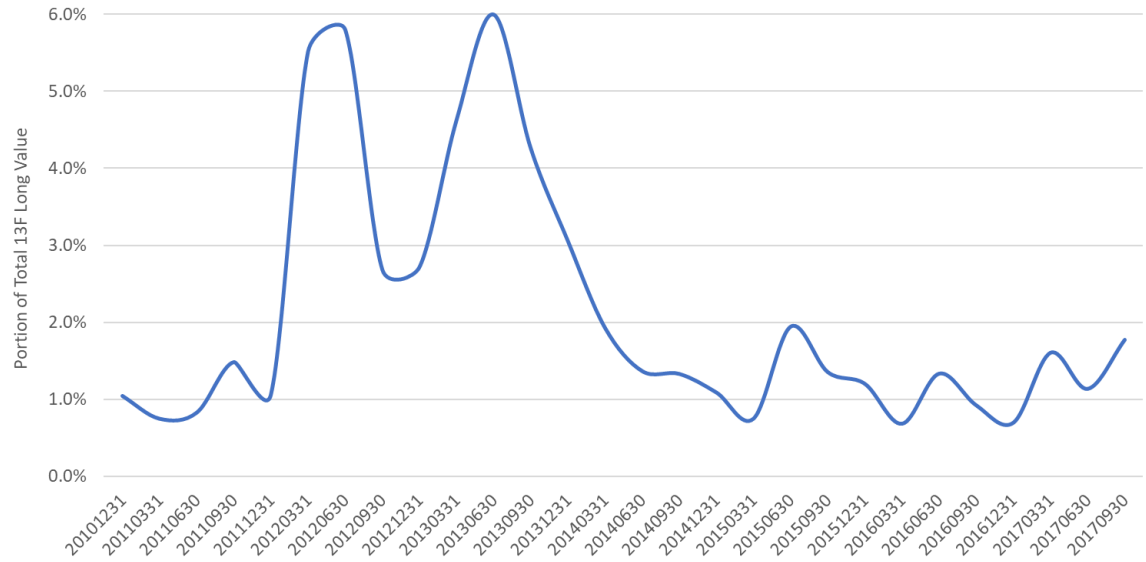
Source: Alphacution, SEC

EXHIBIT 17: AVERAGE POSITION VALUE BY PRODUCT CLASS, Q4 2010 – Q3 2017



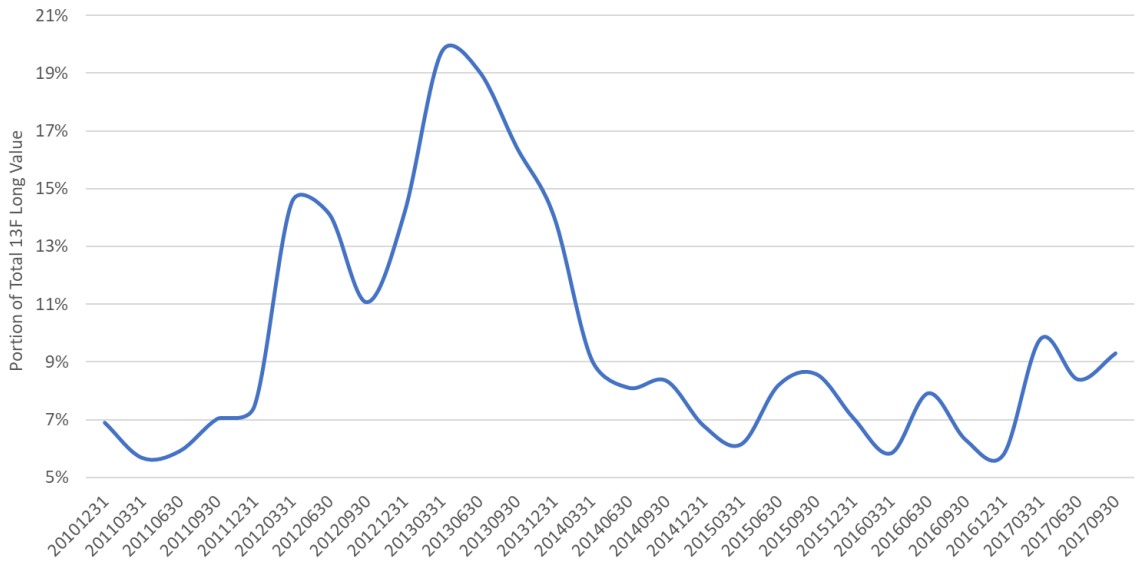
Source: Alphacution, SEC

EXHIBIT 18: LARGEST POSITION AS PERCENTAGE OF ALL 13F POSITIONS, Q4 2010 – Q3 2017



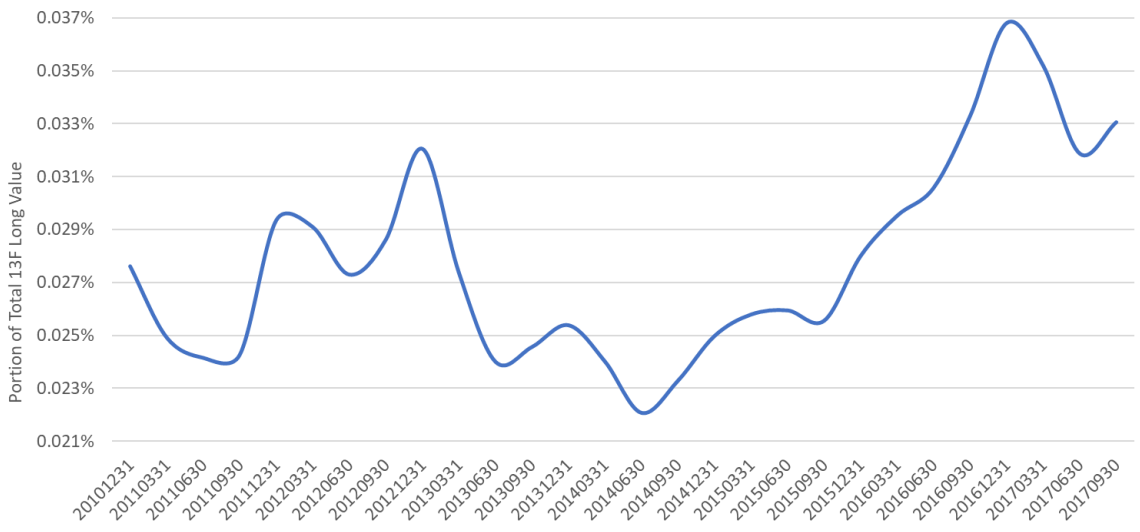
Source: Alphacution, SEC

EXHIBIT 19: TOP 10 POSITIONS AS A PERCENTAGE OF ALL 13F POSITION VALUES, Q4 2010 – Q3 2017



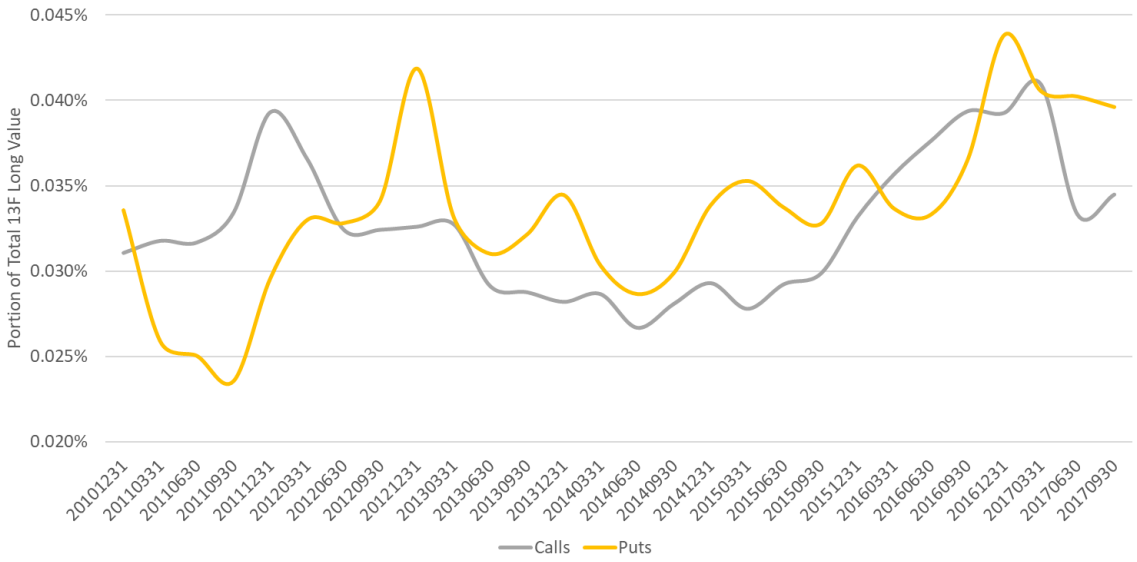
Source: Alphacution, SEC

EXHIBIT 20: AVERAGE POSITION VALUE AS PERCENTAGE OF ALL 13F POSITIONS, Q4 2010 – Q3 2017



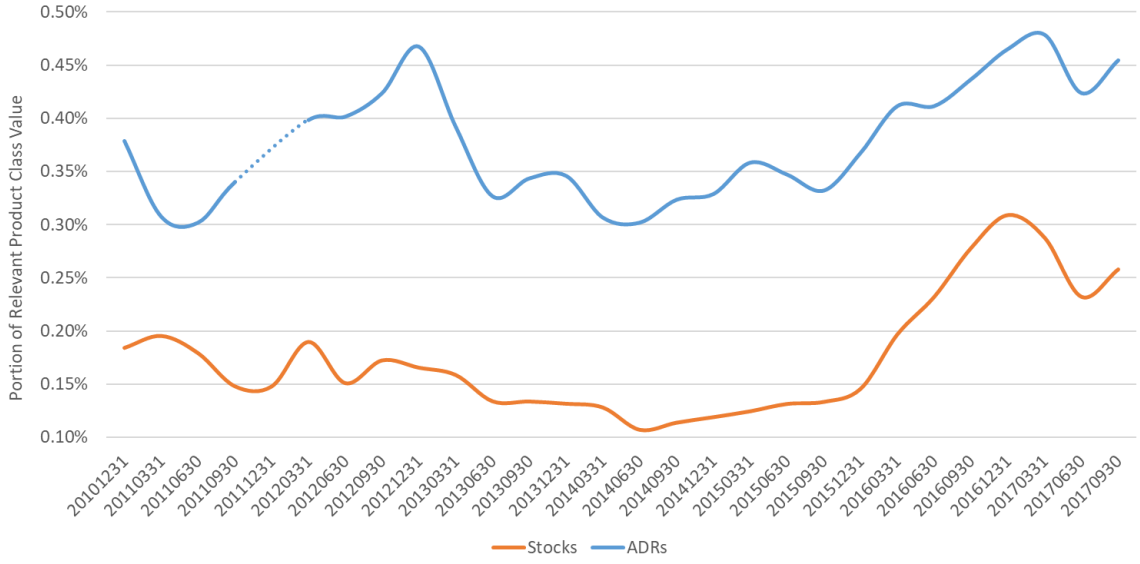
Source: Alphacution, SEC

EXHIBIT 21: AVERAGE DERIVATIVE POSITION VALUE AS PERCENTAGE OF ALL 13F POSITIONS, Q4 2010 – Q3 2017



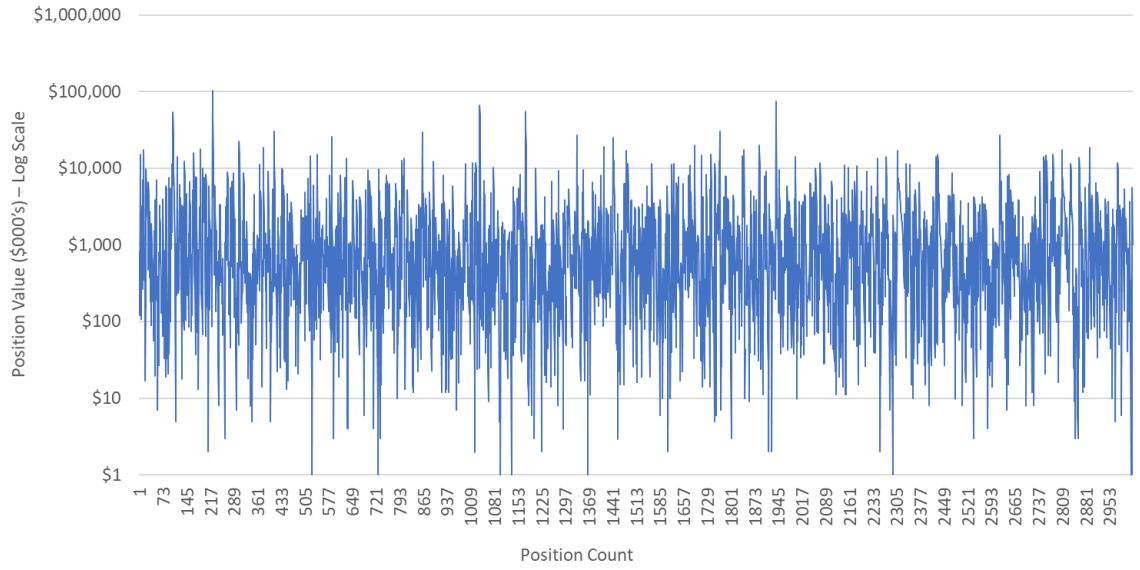
Source: Alphacution, SEC

EXHIBIT 22: AVERAGE POSITION VALUE AS PERCENTAGE OF TOTAL PRODUCT CLASS VALUE, Q4 2010 – Q3 2017



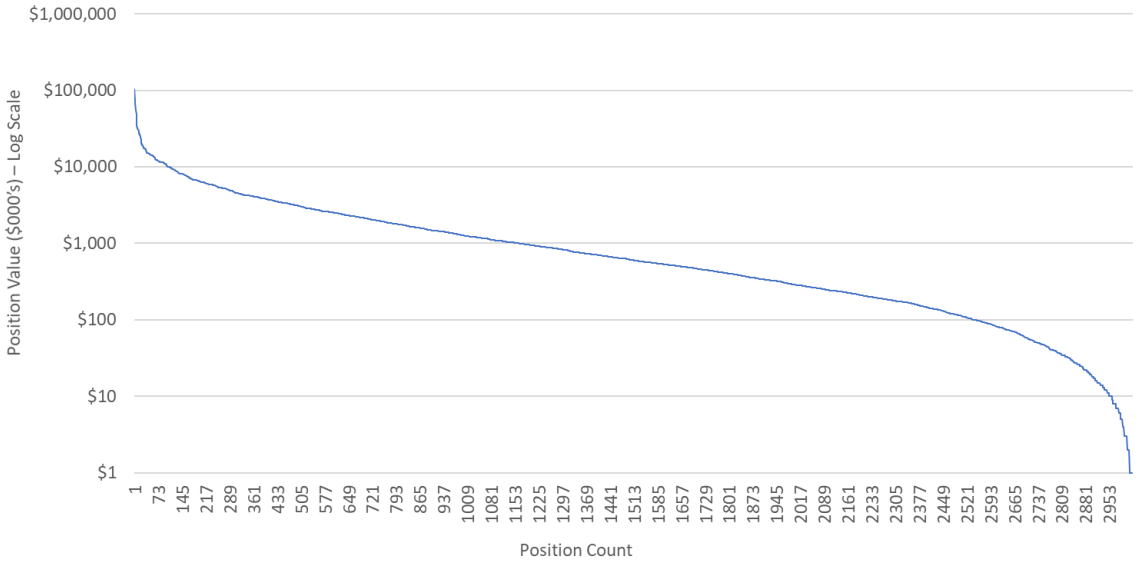
Source: Alphacution, SEC

EXHIBIT 23: SAMPLE POSITION REPORT (Q3-2017) – POSITIONS RANKED ALPHABETICALLY, Q4 2010 – Q3 2017



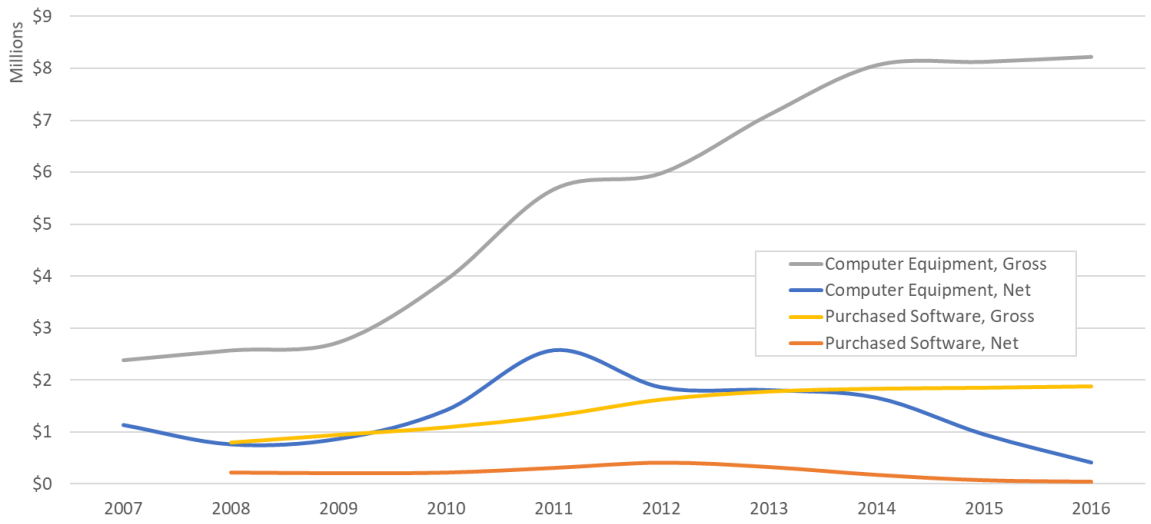
Source: Alphacution, SEC

EXHIBIT 24: SAMPLE POSITION REPORT (Q3-2017) – RANKED BY POSITION VALUE, Q4 2010 – Q3 2017



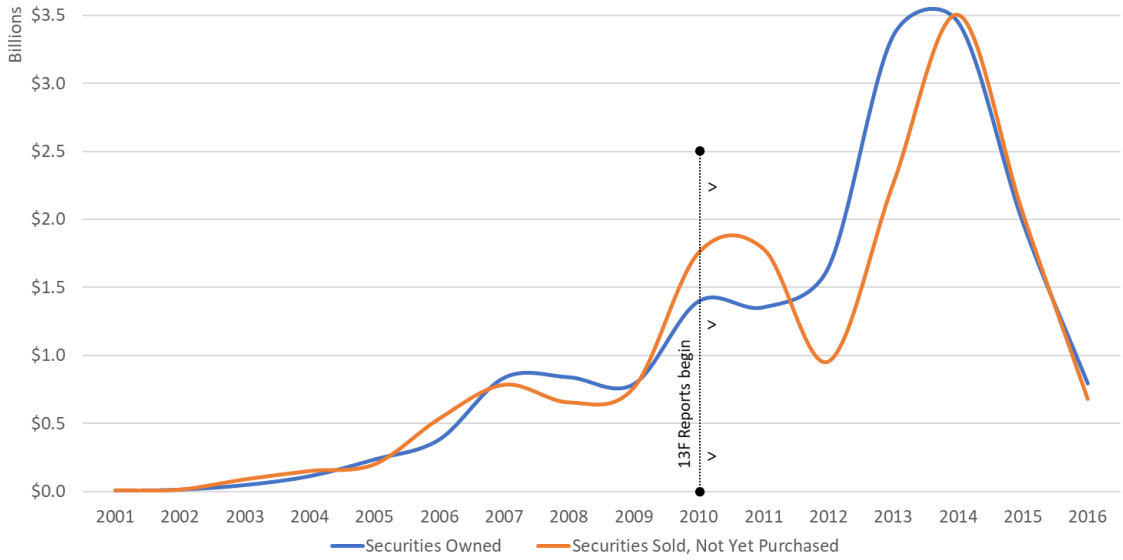
Source: Alphacution, SEC

EXHIBIT 25: TECHNOLOGY INVESTMENTS, 2001-2016



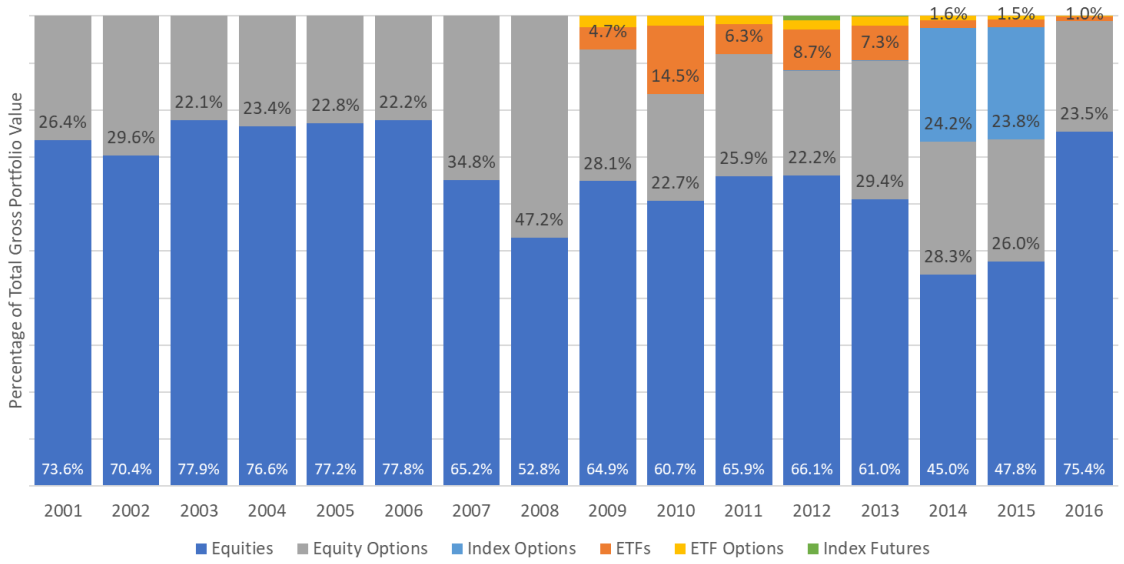
Source: Alphacution, SEC

EXHIBIT 26: TOTAL PORTFOLIO EXPOSURES BY SECURITIES OWNED AND SOLD (NOT YET PURCHASED), 2001-2016



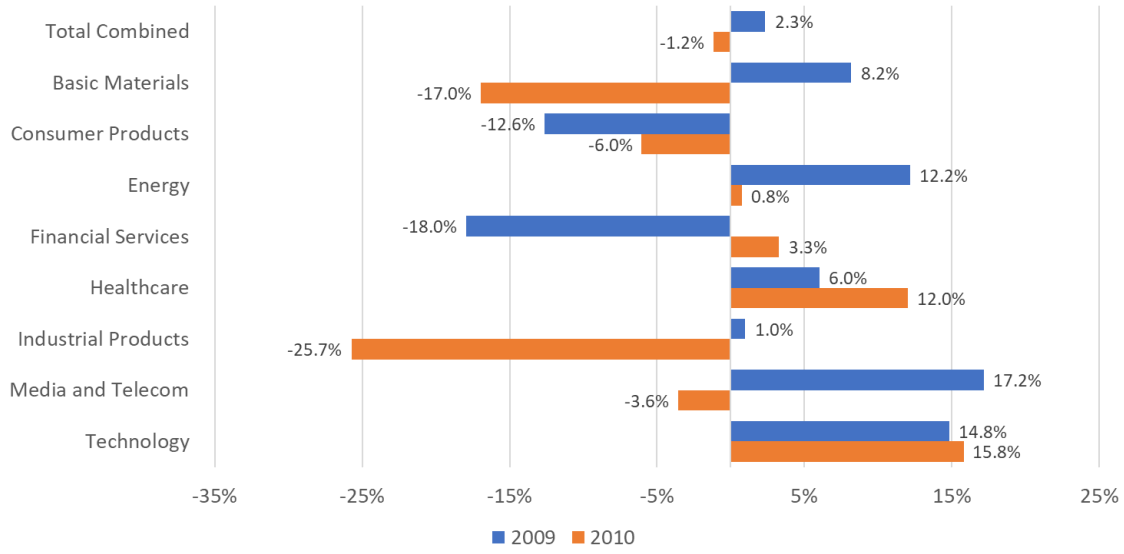
Source: Alphacution, SEC

EXHIBIT 27: PORTFOLIO SEGMENTATION BY PRODUCT CLASS, % OF TOTAL GROSS PORTFOLIO VALUE, 2001-2016



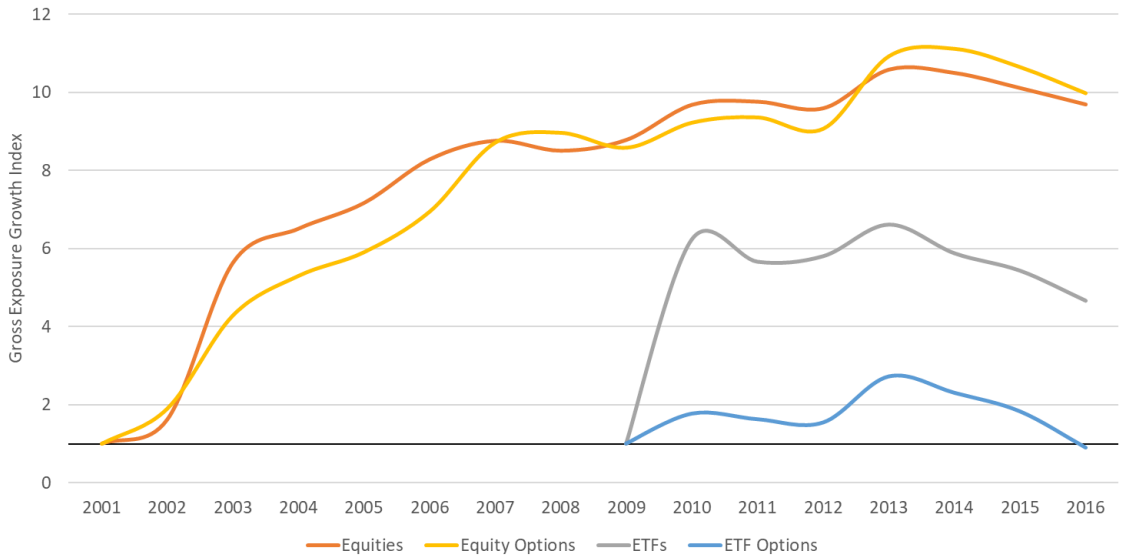
Source: Alphacution, SEC

EXHIBIT 28: DOLLAR NEUTRALITY – ALL EQUITY AND EQUITY OPTIONS POSITIONS BY SECTOR, 2009 - 2010



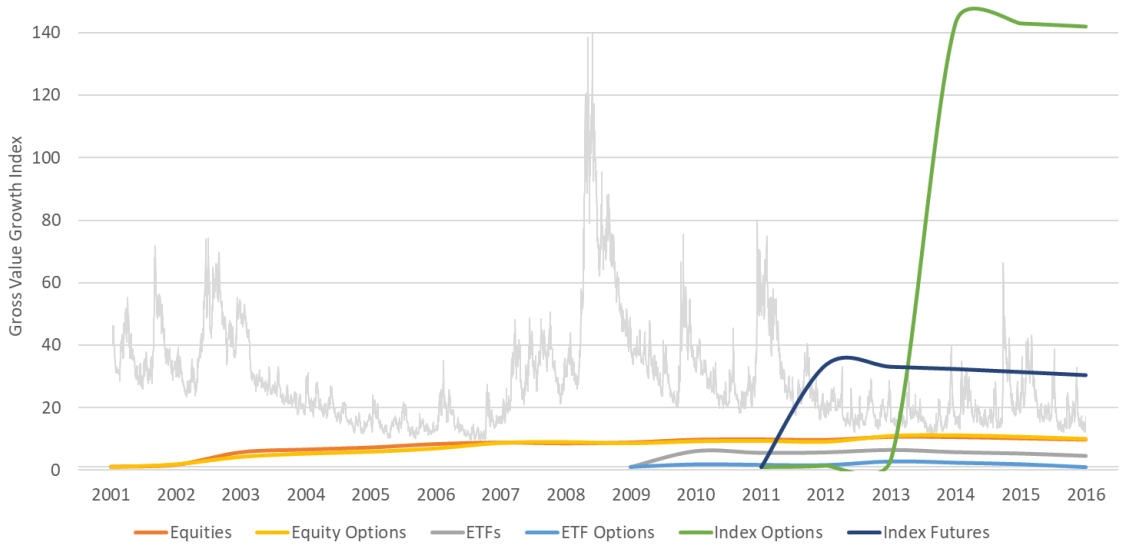
Source: Alphacution, SEC

EXHIBIT 29: GROSS VALUE GROWTH INDEX BY PRODUCT CLASS, 2001-2016



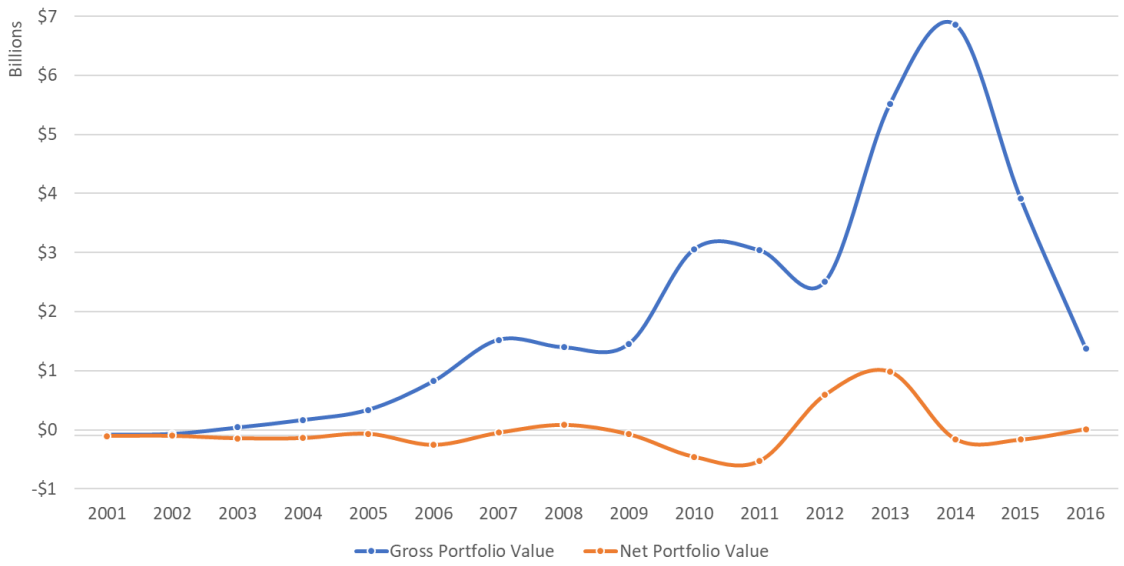
Source: Alphacution, SEC

EXHIBIT 30: GROSS VALUE GROWTH INDEX BY PRODUCT CLASS W/ INDEX OPTIONS, INDEX FUTURES, CBOE VIX VOLATILITY OVERLAY, 2001-2016



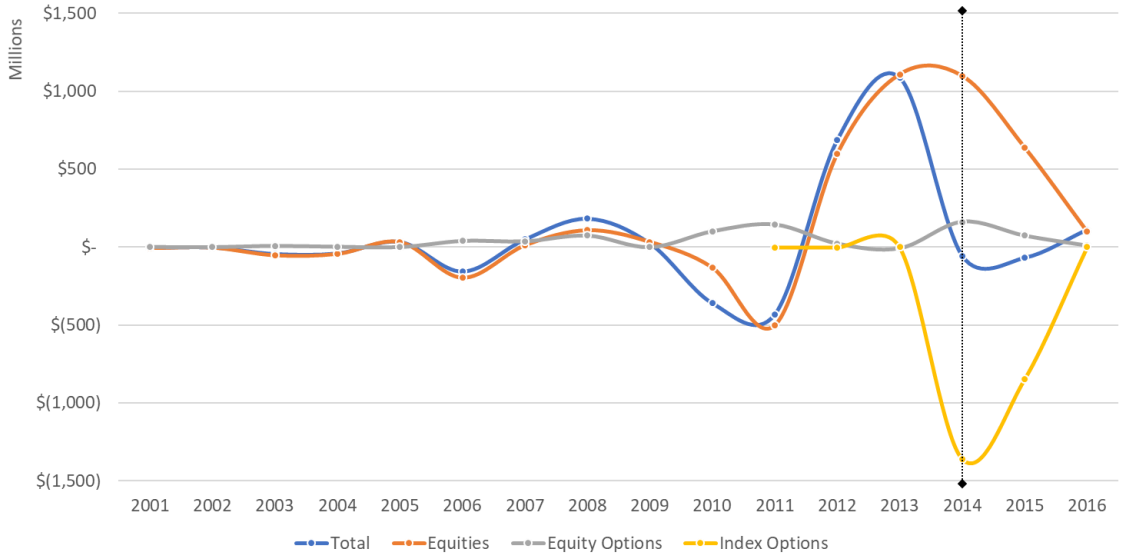
Source: Alphacution, SEC

EXHIBIT 31: COMPARISON OF GROSS AND NET PORTFOLIO DOLLAR VALUE, 2001-2016



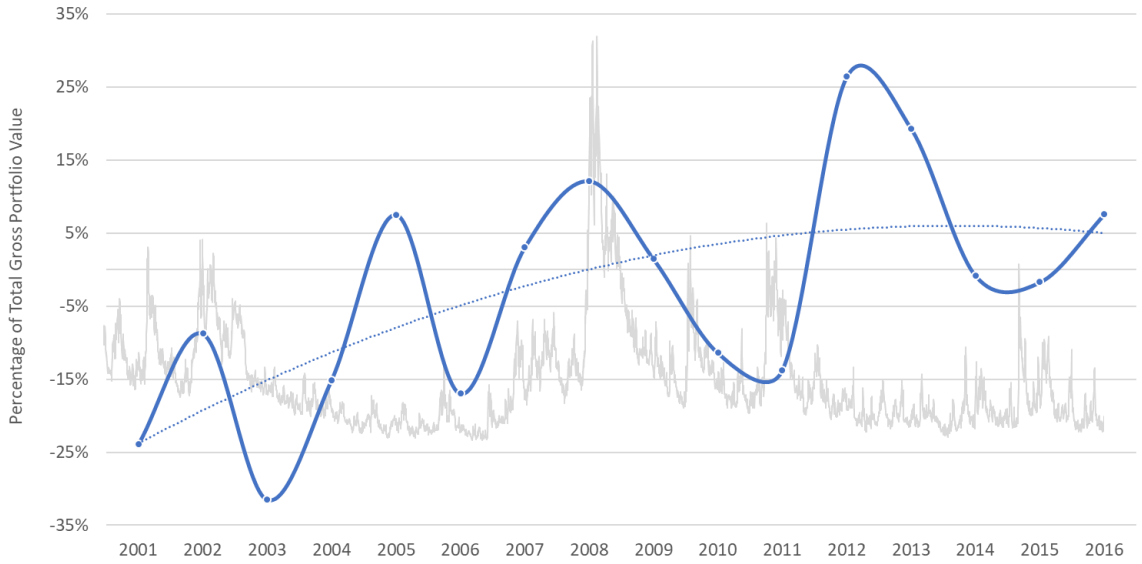
Source: Alphacution, SEC

EXHIBIT 32: NET DOLLAR VALUE BY CORE PRODUCT CLASSES, 2001-2016



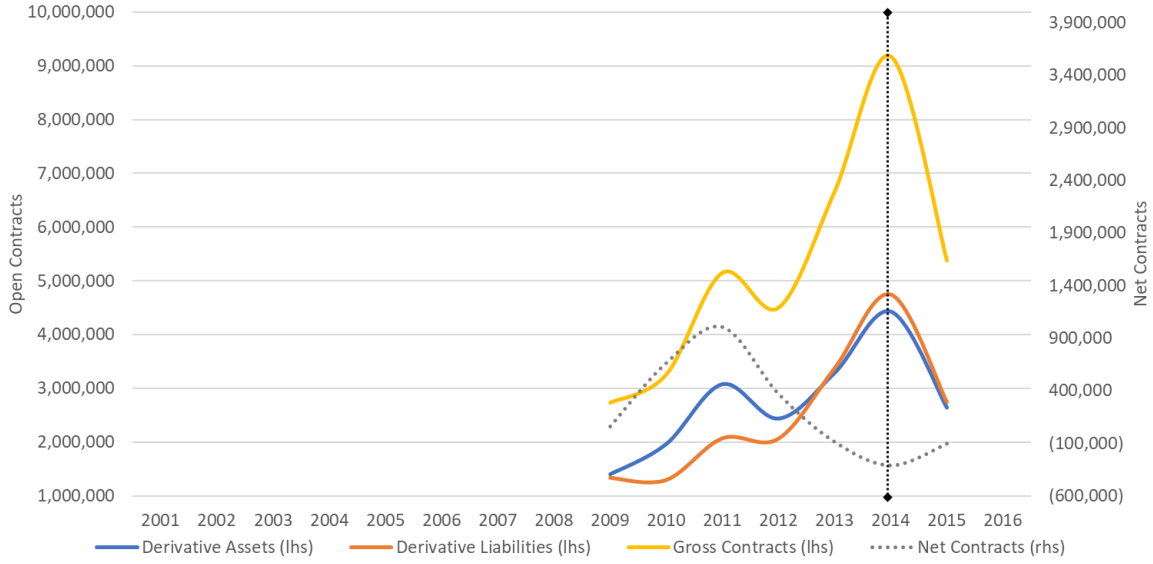
Source: Alphacution, SEC

EXHIBIT 33: PORTFOLIO DOLLAR NEUTRALITY AS % OF GROSS PORTFOLIO VALUE W/ VIX OVERLAY, 2001-2016



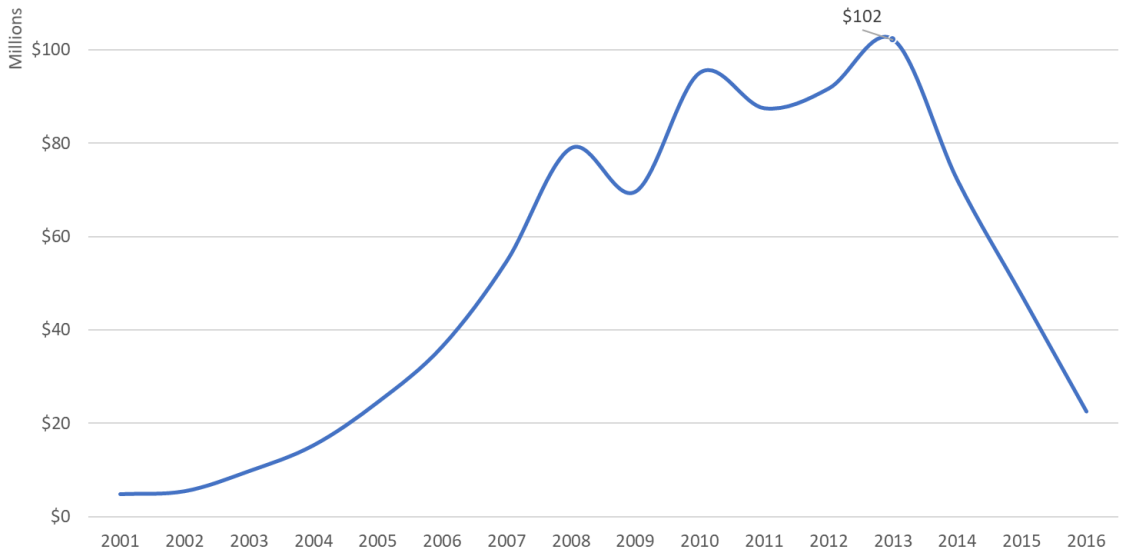
Source: Alphacution, SEC

EXHIBIT 34: DAILY AVG. OPEN, GROSS AND NET CONTRACTS FOR DERIVATIVE ASSETS / LIABILITIES, 2009-2015



Source: Alphacution, SEC

EXHIBIT 35: SPOT TRADING, LLC - MEMBER'S EQUITY, 2001-2016



Source: Alphacution, SEC

ABOUT ALPHACUTION

Alphacution is in the *intelligence* business.

Founded by market veteran Paul Rowady, Alphacution Research Conservatory LLC ("Alphacution") is the first digitally-oriented research and strategic advisory platform uniquely focused on modeling, measuring and benchmarking the evolutionary impacts of technology on global financial markets and the trading, asset management, and banking businesses they serve. Based on an expanding model library focused on specific market actors, composited industry segments, and key themes, the Alphacution platform is specifically designed to deliver data-driven and quantitatively-based intelligence to forward-thinking market participants and their stakeholders.

AUTHOR PAUL ROWADY

Paul Rowady is the Founder and Director of Research for Alphacution Research Conservatory and a 30-year veteran of proprietary, hedge fund and capital markets research, trading and risk advisory initiatives. Paul has earned an extremely unique spectrum of expertise across a range of fundamental and quantitative strategy research methods, derivatives trading, risk management, and techno-operational developments including process re-engineering and workflow automation. Prior to founding Alphacution, he was the founding principal of TABB Group's technology, analytics, and data advisory practice. Paul has also held senior roles with firms like O'Connor & Associates – as Research Analyst and Portfolio Manager, Quantlab Financial – as Co-Founder, Head of Trading and Risk, and Ritchie Capital Management – as a Managing Director, Head of Research. Paul earned a Master of Management from the J. L. Kellogg Graduate School of Management at Northwestern University. He was also awarded a patent related to an event-driven trading analysis and volatility prediction interface and system in 2009.

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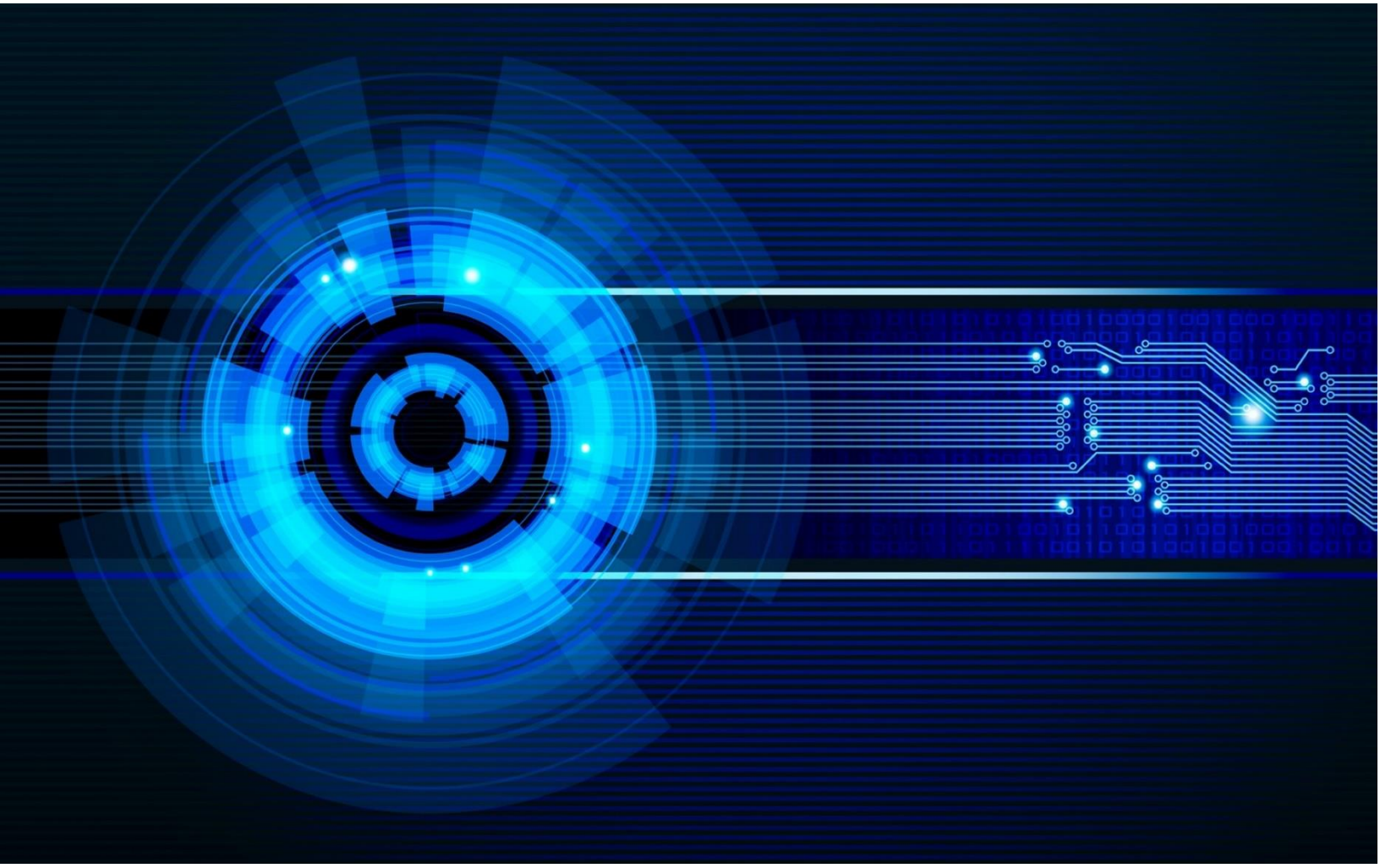

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