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POINT® Hybrid Performance Attribution
Equity Option

We expand the coverage of the POINT Hybrid Performance Attribution (HPA) model to include Equity Options. The model covers both index and single stock options. The total return is split into contribution sources from the underlying cash equity, convexity, implied volatility, and time decay. The user can further customize the decomposition of return into asset allocation and security selection.

Changxiu Li
+1 212 526 1745
changxiu.li@barclays.com

Pamela Zhong
+44 (0)20 3134 7577
yanqiu.zhong@barclays.com

www.barclays.com

Equity Option in POINT®

As a multi-asset portfolio management platform, POINT has been supporting various derivatives including equity options for portfolio construction, risk management, scenario analysis and performance attribution. Equity options are available as central instruments and user-defined-instruments in POINT.

POINT provides an option pricing model (Black-Sholes) to calculate the analytics given the input of the option price or the implied volatility. The (simplified) Taylor expansion for the change in price of the equity options can be formulated as

$$\partial c_t = Delta_{t-1} \times \partial S_t + \frac{Gamma_{t-1}}{2} \times (\partial S_t)^2 + Vega_{t-1} \times \partial \sigma_t + Theta_{t-1} \times \partial t + Rho_{t-1} \times \partial r_t \qquad (1)$$

where c is the option price, S is the underlying stock price, σ is the implied volatility and r is the risk-free rate. The option Greeks are defined according to conventions: Delta is the sensitivity of the option price to the changes in the stock price, Gamma is the sensitivity of Delta to the changes in the stock price, Vega is the sensitivity of the option price to the changes in the volatility of the underlying stock, Theta is the sensitivity of the option price to time and Rho is the sensitivity of the option price to the risk free rate shift.

POINT® Performance Attribution Model for Equity Option

The goal of a performance attribution model is to attribute the portfolio return into the contributions from individual investment decisions. Complex portfolios are typically managed by breaking down the investment process into a sequence of decisions made by different managers. Sector specialized managers are generally responsible for the security selection for a specific asset class. Those sub portfolios are further combined into a diversified portfolio based on the asset allocator's view of the markets. Furthermore, risk-based portfolio managers built overlay strategies to manage common risk factors for the whole portfolio, such as interest rate and foreign exchange. This investment process shows a hierarchy of decisions in the targeting of common risk factors, asset allocation and security selection.

The framework of the POINT® Hybrid Performance Attribution (HPA) model accommodates the decision hierarchies mentioned above, i.e., decomposing the portfolio outperformance into the decisions involving security selection, asset allocation and risk factor overlays. The methodology bridges the factor-based and the sector-based outperformance attribution through two steps: Return splits by risk factors at security level and security allocations at asset class level[1]. The approach is also consist with the one used to develop our equity options risk model[2].

Return Splits by Risk Factors

The return of an equity option is calculated as the P&L divided by its duration basis. Duration basis is the measure for the funded market value, or the notional amount, of a derivative. In particular for equity options:

$$DurationBasis = Num.of\ Contract \times Contract\ Size \times Underlying\ Stock\ Price$$

Consistent with the treatment of other derivatives in HPA, the security level returns are defined in a funded basis. The leverage effect – when we "un-fund" the return – is captured at the asset class bucket level, as explained in detail in the next section.

[1] For more details regarding the HPA model, please refer to *The Barclays Capital Hybrid Performance Attribution Model* .
[2] Please refer to *The US Equity Options Risk Model*

In POINT's HPA, the security's P&L is decomposed into the first four components enumerated by equity (1): Changes in the underlying equity price ($Delta_{t-1} \times \partial S_t$), equity convexity ($\frac{Gamma_{t-1}}{2} \times (\partial S_t)^2$), implied volatility ($Vega_{t-1} \times \partial \sigma_t$) and time decay ($Theta_{t-1} \times \partial t$). These P&L components are further weighted by the security's duration basis to arrive at the de-leveraged return splits. We find the return attributed to the changes in risk free rates ($Rho_{t-1} \times \partial r_t$) to be insignificant and thus exclude them from the return attribution analysis. Figure 1 shows the security return splits for two days of a collection of Apple stock options maturing in four months. The sample contains three calls and three puts at different levels of moneyness (underlying price about $500). In general the return decomposition using the Greeks is able to explain the majority of the total return. The residuals capture the non-linearity missed by our four Greeks approach. They are typically small, but can increase, namely for options far out of the money.

FIGURE 1

Return Splits of Apple Stock Options (2/3/2014-2/5/2014)

		Equity Return Splits					Total
Bucket/Issue	Ticker	Delta	Gamma	Vega	Theta	Residual	Return
AAPL_CALL_450	AAPL	1.814	0.029	0.358	-0.011	0.003	2.193
AAPL_CALL_500	AAPL	0.061	0.016	-0.013	-0.002	0.000	0.062
AAPL_CALL_550	AAPL	-1.853	0.033	-0.976	-0.025	0.267	-2.554
AAPL_PUT_450	AAPL	-0.009	0.004	0.002	0.000	-0.002	-0.005
AAPL_PUT_500	AAPL	-0.948	0.288	-0.274	-0.007	0.042	-0.899
AAPL_PUT_550	AAPL	1.093	0.164	-0.094	-0.003	0.034	1.194

Source: Barclays Research

Asset Allocation, Security Selection and Leverage

As mentioned in the last section, the total return of a particular security is split into two components based on the hierarchy of the investment decisions: one driven by common factors for the entire portfolio and one in excess of common factors, which is further decomposed into asset allocation, security selection and potentially leverage[3]. In the context of equity options, all of the four return split components – underlying equity, convexity, implied volatility and time decay – are security specific. They are therefore considered as allocated – not common – factors.

One key feature of a derivative instrument – such as an equity option - is its leverage. POINT HPA model handles leverage in a way that provides intuitive and meaningful attribution results. As mentioned before, at the instrument level, the returns are defined as its P&L normalized by its duration basis (funded basis). This avoids unintuitive results for derivatives with small (or zero) market values resulting in extremely large (or infinite) returns. On the portfolio or asset class level, however, the returns are defined as the P&L divided by the market value (unfunded basis)[4] – as portfolio managers tend to measure their performance. This dichotomy gives rise to an additional source of outperformance – leverage. In general, this leverage effect is wrapped into the security selection effect, implying that equity option is used to lever the sector return, rather than to manage the sector exposures[5].

[3] POINT offers four configurations that support most portfolio management common factor decision structures, i.e., total return, excess return, spread return and DTS return models. For equity options, all configurations deliver the same results (total returns). Details of the algorithm can be found in *The Barclays Capital Hybrid Performance Attribution Model*

[4] Net basis and gross market value can also be chosen as the denominator for the entire portfolio to allow analysis of highly leveraged and long-short funds.

[5] This is especially true when the benchmark does not contain derivatives.

The following formulas summarize a top-down decomposition of the total outperformance into asset allocation, security selection and bucket leverage[6]:

Asset Allocation: $\sum_S (w_S^P - w_S^B) \times R_S^B$

Security Selection: $\sum_S w_S^P \times (R_S^P - R_S^B)$

Security Contribution: $\sum_S \{\sum_{i \epsilon S} [w_S^P \times (\frac{Basis^P{}_i}{MV^P{}_S} - \frac{Basis^P{}_S}{MV^P{}_S} \times \frac{Basis^B{}_i}{Basis^B{}_S}) \times (R_i - R_S^B)]\}$ (2)

Bucket Leverage: $\sum_S [w_S^P \times (\frac{Basis^P{}_S}{MV^P{}_S} - \frac{Basis^B{}_S}{MV^B{}_S}) \times R_S^B$ (3)

In the formulas, w_S^P and w_S^B are the market value weights of sector S as of the overall portfolio and benchmark respectively. Sector level returns, R_S^P and R_S^B, on unfunded basis, are defined as the sector P&L divided by its market value. Security level return, R_i, on the contrary, is the funded return that is defined as the security's P&L divided by its duration basis.

FIGURE 2

Security Selection against Apple Stock as Benchmark

		MV (%)		Ret ex Common Factors		Outperformance	
Bucket/Issue	Ticker	Port	Bench	Port	Bench	Security Selection	Total
USD		100.0	100.0	-0.182	2.205	-2.387	-2.387
INDUSTRIAL-CA		100.0	100.0	-0.182	2.205	-2.387	-2.387
AAPL_CALL_450	AAPL	424.9		2.193		-0.052	-0.052
AAPL_CALL_500	AAPL	424.9		1.194		-4.297	-4.297
AAPL_CALL_550	AAPL	424.9		0.062		-9.130	-9.130
AAPL_PUT_450	AAPL	424.9		-0.005		-9.414	-9.414
AAPL_PUT_500	AAPL	424.9		-0.899		-13.224	-13.224
AAPL_PUT_550	AAPL	424.9		-2.554		-20.416	-20.416
Bmark Securities	AAPL - Not in pf		100.0		2.205	0.000	0.000
Bucket Leverage						54.146	54.146

Source: Barclays Research

Figure 2 demonstrates how we decompose the security selection into security contribution and the bucket leverage. In the example, we run the portfolio (six Apple stock options as shown in Figure 1) against the benchmark portfolio that contains Apple stock only. The security contribution essentially measures the outperformance assuming that the benchmark had the same leverage ($\frac{Basis_S}{MV_S}$) level as the portfolio for each bucket[7]. This can be seen from equation (2) that the benchmark return on bucket s, R_S^B, is effectively amplified by $\frac{Basis^P{}_S}{MV^P{}_S}$. Correspondingly, the bucket leverage captures the benchmark return that is resulted from the assumed leverage[8].

[6] The formulas are based on a benchmark free of derivative instruments. Under this condition, it is easy to prove that the security selection is equal to the sum of the security contribution and the bucket leverage. For benchmarks with derivatives, the leverage is handled differently. Please refer to the *Barclays Hybrid Performance Attribution Model* for the details.

[7] Take the example of AAPL_CALL_450, the outperformance at -0.052 is equal to (424.9-0)/100*(2.193-2.205) following the equation (2).

[8] In the example, the bucket leverage at 54.1 is equal to (424.9*6-100)/100*2.205, following the equation (3).

Reference

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