

## Algorithm Performance Comparison

Algorithmic futures trading has recently become very popular among the world's largest commodity trading advisors (CTAs), global macro hedge funds, pension funds and asset managers. Buy side traders use algorithms to efficiently, anonymously, and cost effectively execute their futures trades across global markets. Above all, these traders value consistently good performance in line with benchmarks and expectations. In this environment, it has become utterly essential for traders to analyze and compare alternative sell side algorithm providers in order to select the best broker to achieve investment goals.

Quantitative Brokers (QB) is a fully independent, agency-only broker servicing fixed-income, futures, and cash Treasury product traders with a suite of algorithms that minimize market impact on outright, spread, and multi-leg inter-commodity transactions. QB offers existing and prospective clients free access to a real-time simulator for strategy testing and algorithm performance comparison analysis. Beyond simulations, QB strongly encourages its current and prospective clients to simultaneously route similar actual orders through alternative algorithms to conduct the most realistic performance comparison analysis.

Revolution Capital Management (RCM) is a CTA based in Denver, Colorado. RCM directs trading for approximately \$560 million across a full suite of diversified programs. Revolution's research approach is statistically rigorous and can be summarized as short-term pattern recognition. RCM traders executed similarly sized orders using the arrival price algorithms at Quantitative Brokers and at three of the world's largest bulge bracket banks. RCM was gracious enough to share the results of this comparative analysis.

This analysis covers over 3.3MM futures contracts traded in Revolution's Mosaic Institutional and Emerald Futures Programs from April 10, 2013 to February 12, 2016. Markets included are the E-mini S&P 500 and NASDAQ, Eurex Bund and Bobl, LIFFE Long Gilt, US 5-, 10-, and 30-year Treasury futures, and NYMEX Heating Oil, Crude Oil, and Natural Gas contracts. In total, over 1.7MM contracts were routed at a wide variety of trading times to the three bulge bracket banks' arrival price algorithms and nearly 1.6MM contracts were executed through Quantitative Brokers' Bolt algorithm. Table 1 summarizes the comparative order flow by market.

| Market            | Bulge Bracket Banks |           |            | Quantitative Brokers |           |            |
|-------------------|---------------------|-----------|------------|----------------------|-----------|------------|
|                   | No. Trades          | Avg. Size | Total lots | No. Trades           | Avg. Size | Total lots |
| US 5-yr Note      | 2,819               | 129.7     | 365,624    | 2,671                | 125.9     | 336,279    |
| US 10-yr Note     | 2,807               | 101.1     | 283,788    | 2,625                | 96.6      | 253,575    |
| US 30-yr Bond     | 2,660               | 39.6      | 105,336    | 2,430                | 36.9      | 89,667     |
| Eurex Bobl        | 1,979               | 60.9      | 120,521    | 2,454                | 59.9      | 146,995    |
| Eurex Bund        | 2,496               | 70.2      | 175,219    | 3,023                | 63.5      | 191,961    |
| LIFFE Long Gilt   | 2,371               | 49.7      | 117,839    | 2,816                | 45.4      | 127,846    |
| E-mini S&P        | 3,028               | 69.7      | 211,052    | 2,445                | 67.9      | 166,016    |
| E-mini NASDAQ     | 2,807               | 23.6      | 66,245     | 2,212                | 22.8      | 50,434     |
| NYMEX Heating Oil | 2,238               | 12.7      | 28,423     | 1,942                | 11.4      | 22,139     |
| NYMEX Crude Oil   | 2,525               | 39.4      | 99,485     | 2,108                | 34.9      | 73,569     |
| NYMEX Nat. Gas    | 2,782               | 54.2      | 150,784    | 2,523                | 52.8      | 133,214    |
| <b>Totals</b>     | 28,512              | 60.5      | 1,724,316  | 27,249               | 58.4      | 1,591,694  |

Table 1: Order flow characteristics. Over 3.3MM total lots were executed by Revolution through bulge bracket bank algorithms and QB algorithms. The order samples were broadly similar, although orders were not executed simultaneously through all platforms.

| Market                   | Bid/Ask | Bulge Bracket Banks |        | Quantitative Brokers |        | QB Improvement |        |
|--------------------------|---------|---------------------|--------|----------------------|--------|----------------|--------|
|                          |         | AP                  | I-VWAP | AP                   | I-VWAP | AP             | I-VWAP |
| US 5-yr Note             | 7.81    | 3.14                | 2.22   | 1.53                 | -0.76  | -1.61          | -2.98  |
| US 10-yr Note            | 15.63   | 6.84                | 4.81   | 2.44                 | -0.94  | -4.40          | -5.75  |
| US 30-yr Bond            | 31.25   | 13.6                | 9.16   | 4.18                 | -1.59  | -9.42          | -10.75 |
| Eurex Bobl               | 11.39   | 3.65                | 1.61   | 2.05                 | -0.59  | -1.60          | -2.20  |
| Eurex Bund               | 11.39   | 5.89                | 1.51   | 4.2                  | -1.17  | -1.69          | -2.68  |
| LIFFE Long Gilt          | 14.1    | 6.69                | 1.46   | 6.25                 | -2.14  | -0.44          | -3.60  |
| E-mini S&P               | 12.5    | 5.8                 | 3.54   | 3.56                 | -1.49  | -2.24          | -5.03  |
| E-mini NASDAQ            | 5       | 4.2                 | 1.45   | 2.82                 | -1.11  | -1.38          | -2.56  |
| NYMEX Heating Oil        | 4.2     | 13.95               | 4.12   | 9.66                 | -2.49  | -4.29          | -6.61  |
| NYMEX Crude Oil          | 10      | 13.7                | 2.55   | 9.32                 | -3.52  | -4.38          | -6.07  |
| NYMEX Nat. Gas           | 10      | 12.76               | 3.15   | 10.64                | -3.44  | -2.12          | -6.59  |
| <b>Weighted Average:</b> |         | 6.94                | 3.17   | 4.06                 | -1.44  | -2.88          | -4.61  |

Table 2: Relative performance of bulge bracket and QB algorithms. Positive numbers (black) indicate positive costs or underperformance to benchmark, negative numbers (green) indicate negative slippage or outperformance to benchmark. AP denotes Arrival price and I-VWAP denotes interval VWAP. All figures are in US dollars per lot, using recent EUR and GBP exchange rates for Eurex and LIFFE products. The bid/ask spread in dollars is given for comparison. QB consistently achieved lower slippage than the bulge bracket banks.

The performance comparison primarily uses Arrival Price (AP), the most popular benchmark in the algorithmic space. Although the execution strategies targeted this benchmark, for comparison we also report slippage relative to interval VWAP (I-VWAP): volume-weighted average price during the time the order was executed. Table 2 details the relative performance versus these benchmarks in USD on a per contract basis.

QB's Bolt algorithm was superior to the bulge bracket firms' arrival price algorithms. On the arrival price benchmark, Bolt outperformed the banks' algos by a weighted average of \$2.88 (\$6.94 - \$4.06) per lot. This outperformance was consistent across all markets. With respect to the I-VWAP benchmark, the Bolt algorithm again outperformed the bank algos on a weighted basis by an average of \$4.61 (\$3.17 + \$1.44) per lot. Assuming the entire set of 3.3MM contracts traded were sent either to one venue or the other, utilization of Quantitative Brokers' Bolt algorithm offered a potential transaction cost savings relative to arrival price of over \$9.5MM in 34 months. On a time-weighted basis, this represents approximately 77 basis points of annual performance across the Mosaic Institutional and Emerald Futures Programs.

QB's algorithms achieve their performance using a number of sophisticated quantitative techniques. Order placement and detailed knowledge of exchange matching algorithms help the algorithms achieve high rates of passive fills, which is extremely important in these large-tick markets. Short-term signals based on trade and quote activity, as well as cointegration with related contracts, help decide when to accelerate or hold back. Detailed statistical models of intraday volume, volatility, and quote size calibrate the execution.

We encourage you to reach out to us if you have any questions about this research or our strategies. Contact us at [sales@quantitativebrokers.com](mailto:sales@quantitativebrokers.com).

**Disclaimer** This document contains actual performance results achieved, but past performance is not necessarily indicative of future results. Trading futures and options on futures involves significant risk and may result in unlimited losses. Futures trading is not suitable for all investors. QB offers execution services to institutional investors exclusively.