USING MATLAB TO BRIDGE THE GAP BETWEEN PORTFOLIO MANAGEMENT AND TRADING

Robert Kissell, PhD

April 9, 2014

Kissell Research Group, LLC
1010 Northern Blvd., Suite 208
Great Neck, NY 11021
www.kissellresearch.com
• I-Star Model
• High Frequency Trading (HFT)
• HFT Real-Time Cost Index
  • “A Really Big Announcement”
• Portfolio Management
  • Portfolio Construction,
  • Algorithmic Trading, &
  • Broker Evaluation
• Q & A
MATLAB Functions (Complex)

• **fitnlm, lsqnonlin, & mle**
  • To solve for model parameters

• **arma, garch**
  • To forecast market conditions, volatility, volumes, and imbalances

• **fmincon, fminunc, & quadprog**
  • For Multi-Period Trade Schedule Optimization
R = Expected Returns Vector (N x 1)
   • To solve for model parameters

C = Covariance Matrix (N x N)
   • Stock variances and all pairs of covariance.

I = Trading Costs (N x S x T)
   • Trading costs are a three dimensional matrix, stock, size, and strategy.
   • Trading costs for each stock is two dimensional, size and trading time
     (e.g., strategy, schedule, pov, etc.)

• N = Number of Stocks
• S = Size Categories
• T = Time Categories
Financial Market Complexities

- **Market Conditions**
  - Volatility, Volumes, Intraday Patterns

- **Natural Investors**
  - Investors seeking to earn investment profits
  - Aggregated buying and selling pressure

- **High Frequency Trading**
  - Investors seeking to earn a profit from Natural Investor’s trading.
  - Also known as, Toxic Order Flow, Predatory Investors, Scalping
  - What & How much is happening in the market?
  - 60 Minutes Special (3/30/2014), Michael Lewis
  - Broker Inefficient Order Placement is also hurting investors and costing firms millions and millions and millions.
SECTION 1

I-Star Market Impact Model
M.I. Model – Current State

- Non-Transparent, Black-Box, Functional Form???
- Explanatory Factors
  - Size, Volatility, Strategy/Algorithm, Spreads
  - Liquidity (?), Market Cap (?), Parameters (?), Others (?)
- How often are parameters are updated, analyzed?
- Available via Web, System Connection, FTP (data only)
- Only uses vendor calculated variable calculations
  - ADV, Volatility, and current “point-in-time” only
- Can not incorporate own views (liquidity, volatility, and alpha)

- Is this useful enough for Stock Selection & Portfolio Construction?
  - E.g., Factor Screens / Portfolio Optimization / Back-Testing
- Are these back-box models useful enough to uncover HFT activity?
The I-Star Model

\[ I_{bp}^* = \hat{a}_1 \cdot \text{Size}^{\hat{a}_2} \cdot \sigma^{\hat{a}_3} \]

\[ MI_{bp} = \hat{b}_1 \cdot I^* \cdot \text{POV}^{\hat{a}_4} + \left(1 - \hat{b}_1\right) \cdot I^* \]

Variables:

Size = % ADV (expressed as a decimal)

\( \sigma \) = annualized volatility (expressed as a decimal)

POV = percentage of volume (expressed as a decimal)

\( a_1, a_2, a_3, a_4, b_1 \) = model parameters

Constraints: \( a_k > 0; \ 0 \leq b_1 \leq 1 \)

Estimating Model Parameters

- Tic Data
  - Inferred Buy/Sell Imbalance
  - Bid & Offer
  - Price Appreciation / Market Movement
- End of Day / Point in Time
  - Log Price Change
  - Volume, Buy Volume, Sell Volume
  - Average Daily Volume
  - Volatility
- Non-Linear Regression
  - Convergence Algorithm
  - Non-R2

Variables

\[ Side = \text{sign}(\text{Buy Volume} - \text{Sell Volume}) \]

\[ X = Side \cdot (\text{Buy Volume} - \text{Sell Volume}) \]

\[ POV = \frac{X}{Volume} \]

\[ Size = \frac{X}{ADV} \]

\[ MI = Side \cdot \ln\left(\frac{\text{VWAP}}{P_0}\right) \cdot 10^4 \text{bp} \]

We ran an iterative optimization process in MATLAB to determine the models sensitivity to changing parameters.

Each parameter was held constant at specified value, and we determined the best fit non-linear regression model for the other parameters.

For example:

- set $a_1 = 200$ solve for $a_2$, $a_3$, $a_4$, $b_1$
- set $a_1 = 225$ and solve for $a_2$, $a_3$, $a_4$, $b_1$
- Repeat for all feasible values of $a_1$, continue for other parameters

Non-Linear R2 was our evaluation statistic.

The results of this test showed that there are ranges of feasible values provide “equivalent” solutions.
Estimating Parameters: Non-Linear R2

\[ I_{bp} = \hat{a}_1 \cdot \text{Size}^{\hat{a}_2} \cdot \sigma^{\hat{a}_3} \]
\[ MI_{bp} = \hat{b}_1 \cdot I^* \cdot \text{POV}^{\hat{a}_4} + (1 - \hat{b}_1) \cdot I^* \]

Estimating Parameters: Non-Linear R2

\[ I_{bp}^* = \hat{a}_1 \cdot \text{Size}^{\hat{a}_2} \cdot \sigma^{\hat{a}_3} \]

\[ MI_{bp} = \hat{b}_1 \cdot I^* \cdot \text{POV}^{\hat{a}_4} + (1 - \hat{b}_1) \cdot I^* \]

## Stock Trading Cost Curves

### Market Impact Parameters

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a1:</td>
<td>687</td>
<td>702</td>
<td>992</td>
<td>992</td>
<td>769</td>
<td>762</td>
<td>981</td>
<td>1226</td>
<td>1384</td>
<td>1584</td>
</tr>
<tr>
<td>a2:</td>
<td>0.63</td>
<td>0.47</td>
<td>0.58</td>
<td>0.65</td>
<td>0.71</td>
<td>0.71</td>
<td>0.70</td>
<td>0.75</td>
<td>0.75</td>
<td>0.65</td>
</tr>
<tr>
<td>a3:</td>
<td>0.64</td>
<td>0.69</td>
<td>0.83</td>
<td>0.83</td>
<td>0.60</td>
<td>0.59</td>
<td>0.72</td>
<td>0.70</td>
<td>0.83</td>
<td>1.00</td>
</tr>
<tr>
<td>a4:</td>
<td>0.45</td>
<td>0.60</td>
<td>0.52</td>
<td>0.52</td>
<td>0.50</td>
<td>0.50</td>
<td>0.58</td>
<td>0.50</td>
<td>0.50</td>
<td>0.40</td>
</tr>
<tr>
<td>b1:</td>
<td>0.99</td>
<td>0.94</td>
<td>0.97</td>
<td>0.96</td>
<td>0.87</td>
<td>0.86</td>
<td>0.93</td>
<td>0.91</td>
<td>0.83</td>
<td>0.82</td>
</tr>
</tbody>
</table>

### SP500 Index

<table>
<thead>
<tr>
<th>Order Size</th>
<th>1-day</th>
<th>VWAP</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>25%</th>
<th>30%</th>
<th>35%</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>% ADV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>10</td>
<td>10</td>
<td>13</td>
<td>16</td>
<td>18</td>
<td>19</td>
<td>21</td>
<td>22</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>20</td>
<td>16</td>
<td>21</td>
<td>25</td>
<td>29</td>
<td>32</td>
<td>34</td>
<td>36</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>15%</td>
<td>32</td>
<td>21</td>
<td>28</td>
<td>34</td>
<td>38</td>
<td>42</td>
<td>45</td>
<td>48</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td>43</td>
<td>26</td>
<td>35</td>
<td>41</td>
<td>47</td>
<td>51</td>
<td>55</td>
<td>59</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td>54</td>
<td>30</td>
<td>40</td>
<td>48</td>
<td>54</td>
<td>60</td>
<td>65</td>
<td>69</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>30%</td>
<td>66</td>
<td>34</td>
<td>46</td>
<td>55</td>
<td>62</td>
<td>68</td>
<td>74</td>
<td>79</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>35%</td>
<td>77</td>
<td>38</td>
<td>51</td>
<td>61</td>
<td>69</td>
<td>76</td>
<td>82</td>
<td>88</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td>88</td>
<td>42</td>
<td>56</td>
<td>67</td>
<td>76</td>
<td>83</td>
<td>90</td>
<td>96</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>45%</td>
<td>99</td>
<td>46</td>
<td>61</td>
<td>72</td>
<td>82</td>
<td>90</td>
<td>98</td>
<td>105</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>110</td>
<td>49</td>
<td>66</td>
<td>78</td>
<td>88</td>
<td>97</td>
<td>105</td>
<td>113</td>
<td>119</td>
<td></td>
</tr>
</tbody>
</table>

### R2000 Index

<table>
<thead>
<tr>
<th>Order Size</th>
<th>1-day</th>
<th>VWAP</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>25%</th>
<th>30%</th>
<th>35%</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>% ADV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>5</td>
<td>10</td>
<td>14</td>
<td>17</td>
<td>19</td>
<td>22</td>
<td>24</td>
<td>26</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>20</td>
<td>21</td>
<td>29</td>
<td>36</td>
<td>41</td>
<td>46</td>
<td>51</td>
<td>55</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>39</td>
<td>29</td>
<td>40</td>
<td>49</td>
<td>57</td>
<td>64</td>
<td>71</td>
<td>76</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>15%</td>
<td>56</td>
<td>35</td>
<td>49</td>
<td>60</td>
<td>78</td>
<td>85</td>
<td>93</td>
<td>99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td>72</td>
<td>40</td>
<td>56</td>
<td>69</td>
<td>79</td>
<td>89</td>
<td>98</td>
<td>106</td>
<td>114</td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td>88</td>
<td>44</td>
<td>62</td>
<td>76</td>
<td>88</td>
<td>99</td>
<td>109</td>
<td>118</td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>30%</td>
<td>104</td>
<td>48</td>
<td>68</td>
<td>83</td>
<td>96</td>
<td>108</td>
<td>119</td>
<td>129</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td>35%</td>
<td>118</td>
<td>52</td>
<td>73</td>
<td>89</td>
<td>104</td>
<td>116</td>
<td>128</td>
<td>138</td>
<td>148</td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td>133</td>
<td>56</td>
<td>78</td>
<td>95</td>
<td>110</td>
<td>124</td>
<td>136</td>
<td>147</td>
<td>158</td>
<td></td>
</tr>
<tr>
<td>45%</td>
<td>146</td>
<td>59</td>
<td>82</td>
<td>101</td>
<td>117</td>
<td>131</td>
<td>144</td>
<td>156</td>
<td>167</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>160</td>
<td>62</td>
<td>86</td>
<td>106</td>
<td>123</td>
<td>137</td>
<td>151</td>
<td>164</td>
<td>176</td>
<td></td>
</tr>
</tbody>
</table>

SECTION 2
High Frequency Trading
What is High Frequency Trading?

• Any market participate who is looking to earn a Trading Profit. These are revenues that are earned throughout the trading day simply from buying at a lower price and selling at a higher price. These participants for the most part will net out their positions by end of day. They do not carry any over-night risk.
  
  • HFT trading includes: profiting from rebates, market making activities, short-term mis-pricings and stat-arb opportunities.

• An Investment Profit, on the other hand, is the revenues earned from a stock increasing in value and/or from paying dividends. These participants do not have to net their position by end of the day and will carry over-night positions and risk.

• Who are the HFT players?
  
  • HFT firms, Days Traders, High Velocity Traders, Broker Auto Market Making, Broker Principal Desks, Hedge Fund Quants, Hedge Fund Stat-Arb, Traditional Quants.
Brief History of HFT “Terminology”

- Informed Investors
- SOES Bandits & Day Traders
- Penny Jumping
- Adverse Selection
  - ECN’s, ATS’s, Dark Pools, Crossing Networks
- Toxic Liquidity
- High Frequency Trading (HFT), and now,
- “The Flash Boys”
HOW MUCH VOLUME IS HFT?
How Much is High Frequency Trading?

Volumes by Market Participants

How Much is High Frequency Trading?

Volumes by Market Participants

How much is High Frequency Trading?

- How much of market volumes is HFT (1Q-2014)?
  - Flash Boys = 32%, AMM = 13%, Quant Trading = 16%.
  - Total HFT = 32% to 61%.
- HFT will continue to Increase!
  - HFT has increased 15% in two years.
  - HF Quant (w/ HFT techniques) increased 25% in two years.
  - B/D AMM has decreased -25% in same period.
- What is the Future of High Frequency Trading?
  - The future is very, very, very bright!
  - All participants need to remain competitive.
  - B/Ds, Research Firm, Asset Managers, Portfolio Construction.
SECTION 3

HFT Cost Index
High Frequency Trading (HFT) Index

- Provides all investors with insight into actual trading activity and real time costs.
- **Imbalance Shares** – The overall buying and selling pressure
- **I-Star Cost** – The Fair Value TCA Cost for the stock based on market imbalances and actual market conditions.
- **HFT Cost** – The incremental cost due to HFT
- **HFT Activity Indicator** - The amount of HFT activity in the stock.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Date</th>
<th>Imbalance Shares</th>
<th>Imbalance %ADV</th>
<th>IStar Cost (bp)</th>
<th>HFT Cost (bp)</th>
<th>HFT Activity Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4/4/2014</td>
<td>-1,152,422</td>
<td>-47.2%</td>
<td>-197.35</td>
<td>63.38</td>
<td>High</td>
</tr>
<tr>
<td>AA</td>
<td>4/4/2014</td>
<td>1,313,121</td>
<td>5.5%</td>
<td>-72.75</td>
<td>2.49</td>
<td>Low</td>
</tr>
<tr>
<td>AAN</td>
<td>4/4/2014</td>
<td>53,185</td>
<td>5.4%</td>
<td>-69.86</td>
<td>-2.19</td>
<td>Low</td>
</tr>
<tr>
<td>AAON</td>
<td>4/4/2014</td>
<td>-61,927</td>
<td>-45.7%</td>
<td>-274.66</td>
<td>49.25</td>
<td>Low</td>
</tr>
<tr>
<td>AAP</td>
<td>4/4/2014</td>
<td>-451,149</td>
<td>-56.6%</td>
<td>-201.06</td>
<td>61.21</td>
<td>High</td>
</tr>
<tr>
<td>AAPL</td>
<td>4/4/2014</td>
<td>1,243,435</td>
<td>14.3%</td>
<td>-71.33</td>
<td>-2.68</td>
<td>Low</td>
</tr>
<tr>
<td>AAT</td>
<td>4/4/2014</td>
<td>27,755</td>
<td>15.2%</td>
<td>-54.12</td>
<td>-7.34</td>
<td>Low</td>
</tr>
<tr>
<td>ABAX</td>
<td>4/4/2014</td>
<td>-77,136</td>
<td>-58.4%</td>
<td>-200.86</td>
<td>13.18</td>
<td>Low</td>
</tr>
<tr>
<td>ABBV</td>
<td>4/4/2014</td>
<td>-3,385,027</td>
<td>-57.9%</td>
<td>-221.60</td>
<td>74.70</td>
<td>High</td>
</tr>
<tr>
<td>ABC</td>
<td>4/4/2014</td>
<td>240,467</td>
<td>13.5%</td>
<td>-69.94</td>
<td>-1.28</td>
<td>Low</td>
</tr>
<tr>
<td>ABM</td>
<td>4/4/2014</td>
<td>-106,463</td>
<td>-42.7%</td>
<td>-211.63</td>
<td>72.50</td>
<td>High</td>
</tr>
<tr>
<td>ABMD</td>
<td>4/4/2014</td>
<td>-161,238</td>
<td>-30.9%</td>
<td>-238.56</td>
<td>34.21</td>
<td>Low</td>
</tr>
<tr>
<td>ABT</td>
<td>4/4/2014</td>
<td>2,029,162</td>
<td>24.7%</td>
<td>-46.32</td>
<td>15.44</td>
<td>Med</td>
</tr>
<tr>
<td>ACAT</td>
<td>4/4/2014</td>
<td>-71,095</td>
<td>-42.1%</td>
<td>-189.32</td>
<td>-6.30</td>
<td>Low</td>
</tr>
<tr>
<td>ACC</td>
<td>4/4/2014</td>
<td>606,125</td>
<td>78.0%</td>
<td>46.59</td>
<td>-9.19</td>
<td>Low</td>
</tr>
<tr>
<td>ACE</td>
<td>4/4/2014</td>
<td>383,596</td>
<td>26.1%</td>
<td>-47.65</td>
<td>1.33</td>
<td>Low</td>
</tr>
<tr>
<td>ACI</td>
<td>4/4/2014</td>
<td>3,653,812</td>
<td>43.6%</td>
<td>102.36</td>
<td>-11.08</td>
<td>Low</td>
</tr>
</tbody>
</table>
High Frequency Trading (HFT) Index
AAPL - Historical End of Day (2014)
High Frequency Trading (HFT) Index
AAPL – Intraday Index (4/4/2014)
Historical trading cost indexes: regions, countries, and indexes (1990 – present)

- Back-test investment ideas via portfolio optimization (US, Europe, Asia, Developed, Emerging, Latam, Frontier)
- Expected cost that investors would have incurred historically based on today’s market environment, e.g., decimalization, electronic, algorithms, dark pools, internal crossing, ATS, etc.
- Series can be generated for a constant order size (% Adv), share quantity, or dollar value.
- Customized by market, investment style, stock specific, or any investment objective.

HOW TO USE THE HFT COST INDEX?
Example

- A trader is buying 100,000 shares of stock RLK.
  - Trading Cost is typically $0.10/share.
  - By 12:00pm the cost is already $0.50/share.
  - Trader only executed 50,000 shares.
  - What is the reason for the higher price?
Example #1

• A trader is buying 100,000 shares of stock RLK.
  • Trading Cost is typically $0.10/share.
  • By 12:00pm the cost is already $0.50/share.
  • Trader only executed 50,000 shares.
  • What is the reason for the higher price?

• KRG HFT Real-Time Cost Index:
  • Aggregated Imbalance = +750,000 shares.
  • FV TCA = $0.50/share.
  • HFT Activity = +1,000 shares.
  • HFT Cost = $0.001/share (less than 1 cent/share).

• Conclusion:
  • Higher Cost is due to increased buying pressure in the stock (e.g., +750,000 shares).
  • The cost of $0.50/share is reasonable.
Example #2

• A trader is buying 100,000 shares of stock RLK.
  • Trading Cost is typically $0.10/share.
  • By 12:00 the cost is already $0.50/share.
  • Trader only executed 50,000 shares.
  • What is the reason for the higher price?

• KRG HFT Real-Time Cost Index:
  • Aggregated Imbalance = +50,000 shares.
  • FV TCA = $0.10/share.
  • HFT Activity = +200,000 shares.
  • HFT Cost = $0.40/share.

• Conclusion:
  • Higher cost is due to HFT Activity.
  • HFT = +200,000
  • HFT caused the investor to incur an additional cost of $0.50/share.
Example #3

- A trader is buying 100,000 shares of stock RLK.
  - Trading Cost is typically $0.10/share.
  - By 12:00 the cost is already $0.50/share.
  - Trader only executed 50,000 shares.
  - What is the reason for the higher price?

- KRG HFT Real-Time Cost Index:
  - Aggregated Imbalance = +50,000 shares.
  - FV TCA = $0.10/share.
  - HFT Activity = +1,000 shares.
  - HFT Cost = $0.001/share (less than 1 cent/share).

- Conclusion:
  - Higher cost is due to Broker/Algorithm under-performing.
  - It is not due to HFT or Market Conditions!
  - Investor can discuss revising the algorithm/strategy and realize improvement on the last 50,000 shares.
  - It is not too late to do better!
SECTION 4

Real-Time HFT Cost Index
OUR REALLY BIG ANNOUNCEMENT

HFT REAL-TIME COST INDEX

api.kissellresearch.com/istar/hft
SECTION 5

Portfolio Management
Transparent Market Impact Model

- Once a PM has the MI Model they can incorporate their own views regarding liquidity and volatility (as well as alpha) into the cost estimate.
- This allows proper “stress-testing” of positions to determine the cost to liquidate a position.
- Most often, positions are liquidated in a worse-case scenario, e.g., the stock has fallen out of favor, liquidity has dried up, and volatility has spiked.
- Vendor models incorporate the current point in time variables such as current volatility, current liquidity conditions, and cost estimates for stocks that are well behaved, e.g., we want to own them in our portfolio.
- But the cost to get out is much higher than the cost to get in.
- A transparent model allows:
  - “Stress-testing,” “what-if,” and “sensitivity” analysis
Comparison of Costs in “Normal” and “Stressed Environment”

- $100 million investment in a 100 stock small cap portfolio (market cap weighted)
- MI models provide cost estimates under current market conditions.
- These are usually the most appealing market conditions since the stock is being considered for inclusion in the investment portfolio.
- Average Cost = 106bp

- Stress Test of the same $100 million 100 stock small cap portfolio.
- But here we perform a stress test of costs.
- We consider the impact cost to liquidate the position in a market environment where volatility doubles and liquidity halves.
- A more realistic representation of trading cost when we liquidate because a stock has fallen out of favor
- Average Cost = 298bp (almost 3x as higher!)

Source: MATLAB, Science of Algorithmic Trading and Portfolio Management
R2000: What is the cost to liquidate an order?

- Portfolio Managers often limit holdings in any specific stock based on a percentage of ADV to limit transaction cost.
- These position sizes are often limited in size in case the fund needs to liquidate the position quickly (for example, if the stock falls out of favor or if there is unfavorable news).
- The graph on the top left shows the liquidation cost for sizes of 10% ADV for each stock in the R2000 Index using a full day VWAP strategy. The average liquidation cost across names is about 37bp with majority of costs in the 20bp to 55bp range.
- The graph on the bottom left shows the position size (% adv) that could be held in each stock such that the expected liquidation cost in each name will be about 37bp. Many of these stocks could be held in much larger sizes without adversely affecting its liquidation cost and some of the stocks have to be held in position sizes much lower than 10% Adv.
- This graph (bottom left) was also truncated at a size of 35% Adv to better show the range of sizes.

Conclusions

• High Frequency Trading (HFT) is here to stay!
  • 35% - 60% of total volumes

• HFT is only going to increase!
  • HFT Firms, Brokers (Full Service & Research), Hedge Funds, Institutions, Money Managers

• KRG HFT Index
  • Is HFT helping or hurting?
  • Real-Time (web access, API’s)
  • End of Day (All Stocks)
  • Historical (1990 – Present)
  • HFT Hot List – signs of price trend reversion
References

- Multi-Asset Trading Costs, Journal of Trading, Fall 2013, Vol. 8 No. 4
- Smart Technology for Big Data, Michael Blake, Journal of Trading, Winter 2014, Vol. 9, No. 1
Disclaimer

• NOTICE: Kissell Research Group, LLC is not acting as a municipal advisor and the opinions or views contained herein are not intended to be, and do not constitute, advice within the meaning of Section 975 of the Dodd-Frank Wall Street Reform and Consumer Protection Act.

• This message and any attachments (the "message") is intended for recipient only and not for further distribution without the express written consent of Kissell Research Group, LLC. If you receive this message in error, please delete and destroy all electronic and paper copies and immediately notify the sender. Kissell Research Group, LLC accepts no liability whatsoever for the actions of third parties in this respect. Kissell Research Group, LLC specifically prohibits the disclosure, dissemination, redistribution or reproduction of this material, in whole or in part, without the written permission of Kissell Research Group, LLC. Kissell Research Group, LLC reserves the right, to the extent permitted under applicable law, to monitor electronic communications. Kissell Research Group, LLC reserves the right to retain all messages. By messaging with Kissell Research Group, LLC, you consent to the foregoing.

• This communication is issued by Kissell Research Group, LLC for institutional investors only and is not a product of equity research nor it is a recommendation to buy or sell any security or financial instrument. This report is for informational purposes and is not an official confirmation of terms. It is not guaranteed as to accuracy, nor is it a complete statement of the financial products or markets referred to. Opinions expressed are subject to change without notice and may differ or be contrary to the opinions or recommendations of other Kissell Research Group. LLC employees or departments as a result of using different assumptions and modeling criteria. Unless stated specifically otherwise, this is not a personal recommendation, offer or solicitation to buy or sell and any prices or quotations contained herein are indicative only and not for valuation purposes. Historical and past performance is no indication of future performance or future likelihood. To the extent permitted by law, Kissell Research Group. LLC does not accept any liability arising from the use of this communication. Communications may be monitored.

• For additional information, please contact your Kissell Research Group, LLC contact.

• © Kissell Research Group, LLC. 2013. All rights reserved.