Liquidity Risk Management for Portfolios

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Liquidity Risk data kindly provided by Orissa Group, Inc. (OGI, Inc.)
A few opening claims

- Liquidity risk is well-studied but still an “elusive concept”
- Recent experience suggests that it is central to asset pricing and risk management
  - Liquidity risk drives security prices away from fundamentals
- In other words, markets are not efficient in pricing liquidity risk and hence it presents trading opportunities if exploited properly
What we wish to achieve today

- Establish a practical understanding of liquidity risk
- Introduce extant and new empirical metrics to estimate liquidity risk (or scores) using intraday data
- Introduce simple equity trading strategies to exploit liquidity risk
- Identify liquidity regimes in markets
- Compare US versus Asian equity markets
Understanding Liquidity and Liquidity Risk

- **Definition**
  - **Liquidity** is the ease of trading a security
  - **Liquidity Risk** is the uncertainty associated with liquidity

- **Other Definitions**
  - Ease of availability of financing for very short term maturities
A few observations

- Liquidity is not a fixed property
- Liquidity can suddenly dry up
- Liquidity influences asset returns
- Liquidity is a significant source of risk
- Size and trading volume are insufficient proxies of liquidity
How to measure Liquidity and Liquidity Risk?

- First Step: Estimate the cost of liquidating positions (or illiquidity)
  - Measured as the magnitude of price movements (volume-weighted returns) resulting from order size (dollar volume) – Amihud [2002]
  - Modeled using **intraday trading** data for stock “i” over intraday time interval “t” and in month “m”, appropriately normalized:
    \[
    ILLIQ_{t,m}^i = \frac{|r_{t,m}^i|}{V_{t,m}^i} \times \frac{CPI_t}{CPI_0}
    \]

- Second Step: Estimate the uncertainty in the cost
  - Formulate a time-series model of illiquidity
  - Estimate liquidity risk as the illiquidity shock – Amihud [2002]
    \[
    ILLIQ_t = a + b \times ILLIQ_{t-1} + \varepsilon_t
    \]
Properties of illiquid portfolios

- Largest 3000 US stocks by market capitalization

<table>
<thead>
<tr>
<th>Illiquidity Portfolio</th>
<th>Next month ret</th>
<th>Log dollar trade volume</th>
<th>Log market cap</th>
<th>*ILLIQ COST</th>
<th>Market Beta</th>
<th>Size Beta</th>
<th>Valuation Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.96%</td>
<td>20.75</td>
<td>22.64</td>
<td>0.05%</td>
<td>1.03</td>
<td>0.18</td>
<td>-0.06</td>
</tr>
<tr>
<td>2</td>
<td>0.95%</td>
<td>19.15</td>
<td>20.97</td>
<td>0.34%</td>
<td>1.15</td>
<td>0.58</td>
<td>0.04</td>
</tr>
<tr>
<td>3</td>
<td>1.06%</td>
<td>18.17</td>
<td>20.16</td>
<td>1.01%</td>
<td>1.19</td>
<td>0.83</td>
<td>0.12</td>
</tr>
<tr>
<td>4</td>
<td>1.14%</td>
<td>17.23</td>
<td>19.55</td>
<td>2.26%</td>
<td>1.26</td>
<td>0.86</td>
<td>0.23</td>
</tr>
<tr>
<td>5</td>
<td>1.15%</td>
<td>16.25</td>
<td>19.11</td>
<td>4.19%</td>
<td>1.27</td>
<td>0.79</td>
<td>0.42</td>
</tr>
</tbody>
</table>

**Table 2: Properties of Illiquidity Portfolios.** This table reports the properties of 5 portfolios sorted using *ILLIQ. Portfolio 1 has the lowest illiquidity and Portfolio 5 has the highest illiquidity. The portfolios are formed at the end of each month from a universe of 3000 largest US stocks by average market capitalization for the month. Market, HML and SMB beta are computed using contemporaneous monthly regressions of excess portfolio returns with Fama-French factors for Market (R_m_minus_R_f), Size (SMB) and Valuation (HML). All values are reported as monthly averages for the period 1993-2009.
Liquidation cost (Market Illiquidity Level – MIL)

- Largest 3000 US stocks by market capitalization
- Cost of trading a USD 10 Million position in a day

Market Illiquidity Level (MIL)

Note: MIL and other acronyms / variables are defined in the Appendix
Early warning indicator: liquidity deterioration

- Increase in Liquidation Cost (Capital Markets vs. Market Median)
  - Jan-06 - Jun 07: 22% vs. -23%
  - Jun 07 - Jul 08: 253% vs. 132%
  - Market Universe: US Largest 3000 stocks by market capitalization

![Liquidation Cost: Capital Market vs. Market Average](chart.png)
Market Illiquidity Factor (MIF) measures how liquidity risk is priced by market participants.

**Market Illiquidity Factor (MIF)**

**Cumulative return of illiquid securities relative to liquid securities**
Liquidation regimes - concentrated during crisis
Liquidity regimes

<table>
<thead>
<tr>
<th>Liquidity Level</th>
<th>Liquidity Premium</th>
<th>Abnormal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level Deteriorating</td>
<td>Illiquids Underperform Level Deteriorating</td>
<td>Illiquids Outperform Level Deteriorating</td>
</tr>
<tr>
<td>&quot;flight-for-liquidity&quot;</td>
<td>&quot;deleveraging&quot;</td>
<td>&quot;deleveraging&quot;</td>
</tr>
<tr>
<td>Level Improving</td>
<td>Abnormal Illiquids Underperform Level Improving</td>
<td>Illiquids Outperform Level Improving</td>
</tr>
<tr>
<td>&quot;liquidity-correction&quot;</td>
<td>&quot;benign&quot;</td>
<td>&quot;benign&quot;</td>
</tr>
</tbody>
</table>

US Market Illiquidity Factor™ (MIF)

US Median Liquidation Cost

Liquidity deteriorates
Illiquids outperform
("deleveraging" regime)
Liquidity improves
Illiquids outperform
("benign" regime)
Liquidity deteriorates
Illiquids underperform
("flight-for-liquidity" regime)
Liquidity improves
Illiquids underperform
("liquidity-correction" regime)
Applications in active portfolio management: Liquidity analysis presents alpha generation opportunities

- When Market Illiquidity Level increases (i.e., as liquidity deteriorates)
  - Investors favor liquid securities over illiquid securities
  - US: Russell 2000 (proxy for illiquid securities) underperforms DJ Industrial Average (proxy for liquid securities)

- When Market Illiquidity Level decreases (i.e., as liquidity improves)
  - Market participants favor illiquid securities over liquid securities
  - US: Russell 2000 outperforms DJ Industrial Average

<table>
<thead>
<tr>
<th>Trailing Liquidity</th>
<th># of weeks</th>
<th>Return</th>
<th>Std Dev</th>
<th>Return</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deteriorating</td>
<td>384</td>
<td>-3.6%</td>
<td>7.6%</td>
<td>25.2%</td>
<td>19.8%</td>
</tr>
<tr>
<td>Improving</td>
<td>484</td>
<td>17.6%</td>
<td>9.0%</td>
<td>17.8%</td>
<td>15.2%</td>
</tr>
</tbody>
</table>

Analysis period: Jan 1, 1993 through Nov 20, 2009
Applications in active portfolio management: Liquidity Analysis presents alpha generation opportunities

- When Market Liquidity deteriorates
  - **Short** Russell 2000 (RUT)
  - **Long** Dow Jones Industrial Average (DJI)

- When Market Liquidity improves
  - **Long** Russell 2000 (RUT)
  - **Short** Dow Jones Industrial Average (DJI)

- Weekly rebalancing

- Outperforms
  - Naïve Long DJI / Short RUT strategy
  - HFR Equity Market Neutral strategy

- The liquidity based trading signal is persistent

- Results does not consider transaction costs
Applications in passive portfolio management: Determining optimal holding periods

The U.S. evidence suggests

- for shorter holding periods (less than 3 quarters) **liquid securities** provide a higher return on investments
- for longer holding periods (more than 3 quarters) **illiquid securities** provide a higher return on investments

Notes

1. Liquidity Risk is expressed using the Stock Liquidity Rating (SLR) scheme: (AAA, AA, A, BBB, BB, B, CCC, CC, C and D) with AAA having lowest risk and D having highest risk

2. Cumulative Return is the equally weighted return for given SLR portfolio, adjusted for round trip market impact cost. A SLR portfolio is defined as all stocks with a given SLR selected from the universe of largest 3000 U.S. stocks. The average size of a portfolio is $300 million. The portfolio is held constant throughout the holding period.

Applications in Asia: Hong Kong equities versus US equities

- Period Analyzed: Jan – Dec 2007
- Hong Kong Equity market has significantly more liquidity risk as indicated by two liquidity metrics
  - **Liquidity VaR**: This is the cost incurred for liquidating an (equal-weighted) market portfolio. Higher liquidity VaR indicates more liquidity risk.
  - **Turnover**: A lower turnover number (as % of market capitalization) indicates higher liquidity risk.

<table>
<thead>
<tr>
<th>Equity Market</th>
<th># of securities</th>
<th>Total Market Cap (Millions)</th>
<th>Monthly Turnover (Millions)</th>
<th>Avg Daily Turnover as % of Total Market Cap</th>
<th>Liquidity VaR (bps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong (Main Board)</td>
<td>1021</td>
<td>17218587 HK$</td>
<td>1355482 HK$</td>
<td>0.38%</td>
<td>766</td>
</tr>
<tr>
<td>NYSE</td>
<td>2698</td>
<td>15644242 USD</td>
<td>2757078 USD</td>
<td>0.77%</td>
<td>185</td>
</tr>
</tbody>
</table>

**Hong Kong equity market has four times more liquidity risk, and half the average daily turnover, compared to U.S. equity market**
Applications in Asia: Hong Kong equities more vulnerable to liquidity crisis

- The **Market Illiquidity Level (MIL)** is the barometer of liquidity conditions for an Equities Market. An increase in this level indicates deteriorating liquidity conditions.

- US equities’ illiquidity peaked during the last week of November 2007. However, Hong Kong equities illiquidity peaked during the last week of January 2008.

- Hong Kong equities’ illiquidity deteriorated considerably more compared to US Equities.

Source: OGI, Inc.
Applications in Asia: India

OGI Composite India Fund Sample Performance Report
(Source: OGI, Inc.)

<table>
<thead>
<tr>
<th>Time</th>
<th>Portfolio Return</th>
<th>Benchmark Return</th>
<th>Active Return</th>
<th>Currency</th>
<th>Allocation</th>
<th>Selection</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/07/2010</td>
<td>0.62</td>
<td>1.60</td>
<td>-1.05</td>
<td>0.00</td>
<td>-0.01</td>
<td>-1.06</td>
<td>0.02</td>
</tr>
</tbody>
</table>

GICS Sectors:
- Materials: -0.17
- Information Technology: -0.04
- Telecommunication Services: 0.11
- Health Care: -0.09
- Utilities: -0.09
- Industrials: -0.01
- Consumer Discretionary: -0.01
- Consumer Staples: -0.23
- Financials: -0.47
- Energy: -0.33

Investments

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Applications in Asia: India (Cont’d)

OGI Composite India Fund – Top Vs. Bottom
(Source: OGI, Inc.)

<table>
<thead>
<tr>
<th>Top 5 Attribution Contributors</th>
<th>Portfolio</th>
<th>Benchmark</th>
<th>Attribution Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Port</td>
<td>CTR(P)</td>
<td>% Bench</td>
</tr>
<tr>
<td>GREAT EASTERN SHIPPING CO</td>
<td>0.0237</td>
<td>0.17</td>
<td>0.0014</td>
</tr>
<tr>
<td>ESSAR SHIPPING PORTS &amp; LOGS</td>
<td>0.0248</td>
<td>0.13</td>
<td>0.0005</td>
</tr>
<tr>
<td>ORACLE FINANCIAL SERVICES</td>
<td>0.035</td>
<td>0.15</td>
<td>0.0016</td>
</tr>
<tr>
<td>MRF LTD</td>
<td>0.0119</td>
<td>0.12</td>
<td>0.0008</td>
</tr>
<tr>
<td>ALLAHABAD BANK</td>
<td>0.0271</td>
<td>0.12</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bottom 5 Attribution Detractors</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Port</td>
<td>CTR(P)</td>
<td>% Bench</td>
<td>CTR(B)</td>
<td>% Active</td>
<td>Total</td>
</tr>
<tr>
<td>ABAN OFFSHORE LTD</td>
<td>0.0227</td>
<td>-0.39</td>
<td>0.001</td>
<td>-0.02</td>
<td>0.0217</td>
<td>-0.42</td>
</tr>
<tr>
<td>BAJAJ HINDUSTHAN LTD</td>
<td>0.0304</td>
<td>-0.11</td>
<td>0.0006</td>
<td>0.0</td>
<td>0.0299</td>
<td>-0.17</td>
</tr>
<tr>
<td>ISPAT INDUSTRIES LTD</td>
<td>0.0326</td>
<td>-0.1</td>
<td>0.0006</td>
<td>0.0</td>
<td>0.032</td>
<td>-0.15</td>
</tr>
<tr>
<td>TATA TELESERVICES MAHARASHTR</td>
<td>0.0284</td>
<td>-0.09</td>
<td>0.0005</td>
<td>0.0</td>
<td>0.0279</td>
<td>-0.13</td>
</tr>
<tr>
<td>INDIAN BANK</td>
<td>0.0268</td>
<td>-0.07</td>
<td>0.0008</td>
<td>0.0</td>
<td>0.026</td>
<td>-0.11</td>
</tr>
</tbody>
</table>
Summary

- Liquidity Risk an important source of risk and still being understood

- We introduced empirical metrics to estimate liquidity risk using *intraday* data that have predictive ability, both in US and Asian markets

- Introduce practical applications to manage and exploit liquidity risk
Appendix: Definitions

- **Market Illiquidity Level (MIL)** is the median illiquidity level for stocks, as captured by the Stock Illiquidity Level (SIL), for the entire market of stocks selected from a universe of 3,000 largest public U.S. equities by market capitalization, as determined at the beginning of the quarter. The weekly SIL for each stock is determined using intra-day trading data ($ILLIQ_t$). The median SIL across the universe is denoted as MIL. The MIL is based on an initial value of 100 registered on Jan 8, 1993. An increase in MIL indicates deteriorating liquidity conditions. When MIL declines, illiquid securities can be expected to outperform liquid securities. When MIL increases, illiquid securities can be expected to underperform liquid securities.

- **Stock Liquidity Rating (SLR)** measures a stock’s liquidity risk, given by the uncertainty associated with the cost of liquidating a position ($\epsilon_t$). SLR categorizes a stock into one of ten liquidity risk buckets (AAA, AA, A, BBB, BB, B, CCC, CC, C, D), with AAA having the least risk and D the greatest risk.

- **Market Illiquidity Factor (MIF)** measures how liquidity risk is priced by market participants. It measures the cumulative return of illiquid securities relative to liquid securities as ranked by the stock-level liquidity rating system (SLR). The MIF for the U.S Equities Market is created through analysis of the 3,000 largest U.S. stocks. The MIF is based on an initial value of 100 registered on April 1, 1993.