WHAT’S NEW IN V-LAB

ROB ENGLE
WHAT IS NEW IN V-LAB?

• V-LAB IS THE VOLATILITY AND RISK INSTITUTE’S WEB SITE THAT PRESENTS MANY FINANCIAL RISK MEASURES WITH DAILY UPDATES.

• WE HOPE THESE MEASURES WILL HELP INDIVIDUALS AND FIRMS HEDGE, MITIGATE OR TRANSFER THE RISKS THEY DO NOT WANT TO OWN.

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• IT HAS SEVEN PRIMARY DISPLAYS
  • VOLATILITY ANALYSIS
  • CORRELATION ANALYSIS
  • SYSTEMIC RISK ANALYSIS
  • LONG RUN VaR ANALYSIS
  • LIQUIDITY ANALYSIS
  • FIXED INCOME ANALYSIS
  • CLIMATE RISK ANALYSIS

• TODAY WE WILL FIRST DISCUSS COVID-19 CASE STUDY PAGE
COVID-19 CASE STUDY

• We have seen dramatic swings in financial markets all over the world
• This page seeks to relate the financial changes to infection and death rates from a global perspective.
ADDING CONFIRMED CASES TO VOLATILITY

COVID-19 Case Study

Confirmed cases by country

Total cases: 2,561,044
Total deaths: 176,984

See events (52)
VIX RISES WITH THE ACCELERATION OF NEW CASES
STATISTICAL MODELING OF THIS RELATION

- A PANEL REGRESSION MODELS THE RELATION BETWEEN COUNTRY EQUITY VOLATILITY AND MEASURES OF VIRUS INFECTION SINCE JANUARY.

- MODEL FEATURES CURVATURE OF NEW CASES, STRINGENCY OF POLICY, AND SPILLOVERS FROM GLOBAL INFECTIONS.
All variables are based on 3day average log(ActiveCases) in Panel Regressions with Time Fixed Effects OR Global ActiveCases & Curvature OR USA ActiveCases & Curvature

\[ \text{curvature}(t) = \log(\text{ActiveCases}(t)) + \log(\text{ActiveCases}(t-k)) - 2 \cdot \log(\text{ActiveCases}(t-k/2)), \text{ where } k=7 \]

\[
\text{DVOL} = b(1)\log(\text{ActiveCases}[t-1]) + b(2)\text{Curvature(A)}[t-1] + \text{const}
\]

<table>
<thead>
<tr>
<th></th>
<th>Model (SUS)</th>
<th>Model (GLB)</th>
<th>Model (TFE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log(ActiveCases)[t-1]</td>
<td>3.276</td>
<td>6.13</td>
<td>3.529</td>
</tr>
<tr>
<td></td>
<td>[3.76]**</td>
<td>[9.69]**</td>
<td>[4.24]**</td>
</tr>
<tr>
<td>Curvature(A)[t-1]</td>
<td>2.689</td>
<td>1.717</td>
<td>1.158</td>
</tr>
<tr>
<td></td>
<td>[3.81]**</td>
<td>[3.15]**</td>
<td>[2.13]**</td>
</tr>
<tr>
<td>Log(ActiveCases) - USA[t-1]</td>
<td>0.648</td>
<td>[0.97]</td>
<td></td>
</tr>
<tr>
<td>Curvature(A) - USA[t-1]</td>
<td>3.046</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[4.82]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log(ActiveCases) - Global[t-1]</td>
<td></td>
<td>-6.945</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-4.97]**</td>
<td></td>
</tr>
<tr>
<td>Curvature(A) - Global[t-1]</td>
<td></td>
<td>42.288</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[11.47]**</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>4.531</td>
<td>82.324</td>
<td>0.808</td>
</tr>
<tr>
<td></td>
<td>[2.29]**</td>
<td>[5.78]**</td>
<td>[0.63]</td>
</tr>
<tr>
<td>Time Fixed Effects</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>R-Sq - within</td>
<td>0.335</td>
<td>0.502</td>
<td>0.637</td>
</tr>
<tr>
<td>R-Sq - between</td>
<td>0.276</td>
<td>0.267</td>
<td>0.284</td>
</tr>
<tr>
<td>N</td>
<td>4472</td>
<td>4472</td>
<td>4472</td>
</tr>
</tbody>
</table>

NOTE: SUS is Spillover from US. GLB is GlobalCases & Global infection rates. TFE is time fixed effects.
VOLATILITY and CORRELATION
VOLATILITY OF S&P500 and WTI
CORRELATION

• NEW NON-LINEAR SHRINKAGE ESTIMATOR FOR VERY LARGE DYNAMIC CORRELATION MATRICES from Engle, Ledoit and Wolf(2019)

• NEW PRESENTATION FEATURING
  • MULTIDIMENSIONAL SCALING
  • CORRELATIONS OF ONE ASSET WITH ALL OTHER ASSETS
  • AVERAGE OF ALL PAIRS

• Equity correlations are high and rising
• Commodity correlations are low and rising as oil volatility rises
• Exchange rate correlations are falling as some currencies become havens
• US asset class correlations are rising
DEFINITION: SRISK is the number of dollars that would be needed to recapitalize a financial institution so that it can continue to function normally if there is a collapse of the global equity market like in the financial crisis.
UNITED STATES

Risk Analysis Overview - United States Financials Total SRISK (US$ billion)

Date Range: from 04/22/2010 to 04/22/2020

Window: 6M · 1Y · 2Y · 5Y · 10Y · All

SRISK Capacity

SRISK
GLOBAL SRISK

Risk Analysis Overview - All Financials Total SRISK (US$ billion)

Date Range: from 01/01/1990 to 04/22/2020

Window: 6M • 1Y • 2Y • 5Y • 10Y • All
IMPLICATIONS

• GLOBAL SRISK IS AS HIGH AS IT HAS EVER BEEN
• HOWEVER $1 TRILLION IS CHINA WITH STATE OWNED BANKING SYSTEM
• THE LARGEST EUROPEAN BANKS ARE HIGHLY UNDERCAPITALIZED AND SURVIVE BASED ON IMPLICIT GOVERNMENT GUARANTEES
• US BANKS, JAPANESE AND UK BANKS HAVE BEEN GIVEN BIG BACKSTOPS AND TOLD TO CONTINUE LENDING.
• CONSEQUENTLY, RAPID POLICY RESPONSE MAKES THE BANKS LESS LIKELY TO CAUSE FURTHER DAMAGE.
GEOPOLITICAL RISK
GEOVOL

• GEOVOL IS A VOLATILITY FACTOR WHICH MAKES VOLATILITIES OF A BROAD SET OF FINANCIAL ASSETS GO UP AT THE SAME TIME.

• GEOVOL MAY BE DUE TO POLITICAL OR ECONOMIC OR MILITARY OR NOW HEALTH NEWS

• V-LAB WILL ESTIMATE GEOVOL FOR SEVERAL COLLECTIONS OF ASSETS. THE FIRST IS A SET OF COUNTRY EQUITY ETFS.

• THE NEXT SLIDE SHOWS THE CURRENT ESTIMATES.
<table>
<thead>
<tr>
<th>Date</th>
<th>GEOVOL</th>
<th>avgRet</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-06-24</td>
<td>50.619</td>
<td>-7.341</td>
<td>Brexit</td>
</tr>
<tr>
<td>2020-03-09</td>
<td>49.957</td>
<td>-9.634</td>
<td>COVID - All of Italy is locked down, Saudi Arabia / Russia oil price war</td>
</tr>
<tr>
<td>2019-08-05</td>
<td>40.314</td>
<td>-2.575</td>
<td>China Trade War - China devalues its currency</td>
</tr>
<tr>
<td>2001-09-17</td>
<td>29.733</td>
<td>-8.630</td>
<td>Market reopens after Sept 11th</td>
</tr>
<tr>
<td>2015-08-24</td>
<td>22.561</td>
<td>-4.146</td>
<td>Flash Crash</td>
</tr>
<tr>
<td>2017-04-24</td>
<td>22.542</td>
<td>2.070</td>
<td>Syrian sanctions</td>
</tr>
<tr>
<td>2016-11-09</td>
<td>18.569</td>
<td>-1.285</td>
<td>Trump Elected</td>
</tr>
<tr>
<td>2011-08-05</td>
<td>18.261</td>
<td>0.443</td>
<td>Rumors of US credit rating downgrade</td>
</tr>
<tr>
<td>2018-04-09</td>
<td>17.698</td>
<td>0.293</td>
<td>North Korea open to denuclearization, Missles hit Syrian air base</td>
</tr>
<tr>
<td>2020-03-12</td>
<td>17.579</td>
<td>-12.083</td>
<td>COVID - Day after Trump address -- blocks visitors coming in from Europe</td>
</tr>
<tr>
<td>2020-03-13</td>
<td>16.757</td>
<td>6.169</td>
<td>COVID - US declares national state of emergency</td>
</tr>
<tr>
<td>2017-05-18</td>
<td>16.589</td>
<td>-0.683</td>
<td>Justice dept appoints Mueller to head Russia investigation</td>
</tr>
<tr>
<td>2008-10-10</td>
<td>15.024</td>
<td>-2.648</td>
<td>Global Financial Crisis</td>
</tr>
<tr>
<td>2014-12-17</td>
<td>14.904</td>
<td>2.086</td>
<td>Peshawar Pakistan school attacks, US/Cuba re-establish diplomatic relations</td>
</tr>
<tr>
<td>2001-03-12</td>
<td>14.678</td>
<td>-3.429</td>
<td>NASDAQ Market Crash</td>
</tr>
<tr>
<td>2002-07-23</td>
<td>14.564</td>
<td>-3.076</td>
<td>Israeli/Palestinian Tension, Stock Market Crash</td>
</tr>
<tr>
<td>2001-01-03</td>
<td>14.120</td>
<td>3.721</td>
<td>Fed surprise interest rate cut</td>
</tr>
<tr>
<td>2010-05-10</td>
<td>13.983</td>
<td>6.252</td>
<td>EU and IMF reveal a $1 trillion plan to avoid a European debt crisis</td>
</tr>
<tr>
<td>2020-03-19</td>
<td>13.572</td>
<td>1.448</td>
<td>COVID - Coronavirus relief package signed night prior</td>
</tr>
</tbody>
</table>
FACTOR LOADINGS ON GEOVOL

- 1st Principal Component 0.266
  - ACWI MSCI 0.253
  - iShares MSCI France ETF 0.222
  - iShares MSCI Spain Capped ETF 0.202
  - iShares MSCI Italy Capped ETF 0.200
  - iShares MSCI Germany ETF 0.192
  - iShares MSCI Netherlands ETF 0.190
  - iShares MSCI Malaysia ETF 0.182
  - iShares MSCI Finland ETF 0.175
  - iShares MSCI Belgium Capped ETF 0.175
  - iShares MSCI Thailand ETF 0.174
  - SPDR S&P 500 ETF Trust 0.162
  - VanEck Vectors Egypt Index ETF 0.155
  - iShares MSCI Austria ETF 0.151
  - iShares MSCI Indonesia ETF 0.147
  - iShares MSCI South Korea ETF 0.146
  - iShares MSCI Singapore Capped ETF 0.141
  - Global X MSCI Portugal ETF 0.136
  - iShares MSCI Japan ETF 0.134
  - iShares MSCI China ETF 0.133
  - iShares MSCI Sweden Capped ETF 0.133
  - Global X MSCI Greece ETF 0.131
  - iShares MSCI Taiwan Capped ETF 0.130
  - iShares MSCI Chile ETF 0.128
  - iShares MSCI Hong Kong ETF 0.128
  - iShares MSCI Norway ETF 0.127
  - iShares MSCI Philippines ETF 0.123

- 2nd Principal Component 0.123
  - iShares MSCI United Kingdom ETF 0.123
  - iShares MSCI Mexico Capped ETF 0.122
  - iShares MSCI Colombia ETF 0.121
  - iShares MSCI Switzerland Capped ETF 0.118
  - iShares MSCI Brazil Capped ETF 0.117
  - iShares MSCI Israel ETF 0.115
  - iShares MSCI South Africa ETF 0.115
  - Global X MSCI Nigeria ETF 0.114
  - iShares MSCI Qatar ETF 0.114
  - iShares MSCI Denmark ETF 0.113
  - iShares MSCI Australia ETF 0.113
  - iShares MSCI Canada ETF 0.112
  - iShares MSCI Russia ETF 0.109
  - iShares MSCI Ireland ETF 0.106
  - iShares MSCI Turkey ETF 0.101
  - iShares MSCI India ETF 0.095
  - VanEck Vectors Vietnam ETF 0.083
  - iShares MSCI Poland ETF 0.082
  - iShares MSCI Peru ETF 0.079
  - iShares MSCI New Zealand ETF 0.069
  - Global X MSCI Pakistan ETF 0.053
PERFORMANCE METRICS UPDATE

• Green Fund performance metrics: return, Sharpe, 3 Factor FF alpha, beta

• Update using investible factors. ETFs for market, HML, SMB allows up to date performance measure.

• In development phase: Climate news measures are used to see which funds appreciate when there is substantial climate news and which depreciate.

• News metrics are based on daily measures of NYT climate coverage.
Cos-sim and tag index are two measures of climate news. We continue to improve these.

<table>
<thead>
<tr>
<th>Security</th>
<th>Return</th>
<th>Volatility</th>
<th>Sharpe Ratio</th>
<th>Correlation Cos Sim</th>
<th>Correlation Tag Index</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gabelli ESC Fund Inc</td>
<td>-13.52%</td>
<td>28.64%</td>
<td>-0.48</td>
<td>-0.016</td>
<td>0.142</td>
<td>-2.59 (-1.11)</td>
</tr>
<tr>
<td>Invesco Solar ETF</td>
<td>15.15%</td>
<td>47.14%</td>
<td>0.32</td>
<td>0.165</td>
<td>0.123</td>
<td>23.16 (0.86)</td>
</tr>
<tr>
<td>KraneShares MSCI China Environment Index ETF</td>
<td>-10.44%</td>
<td>28.72%</td>
<td>-0.37</td>
<td>0.227</td>
<td>0.123</td>
<td>-1.63 (-0.09)</td>
</tr>
<tr>
<td>BlackRock Equity Dividend Fund</td>
<td>-11.67%</td>
<td>29.57%</td>
<td>-0.40</td>
<td>0.083</td>
<td>0.115</td>
<td>0.48 (0.16)</td>
</tr>
<tr>
<td>Amplitude Advanced Battery Metals and Materials ETF</td>
<td>-40.58%</td>
<td>36.19%</td>
<td>-1.13</td>
<td>0.163</td>
<td>0.115</td>
<td>-36.84 (-1.86)</td>
</tr>
<tr>
<td>Walden International Equity Fund</td>
<td>-9.65%</td>
<td>23.58%</td>
<td>-0.42</td>
<td>0.065</td>
<td>0.113</td>
<td>-1.62 (-0.32)</td>
</tr>
<tr>
<td>Calvert International Equity Fund</td>
<td>-4.07%</td>
<td>26.10%</td>
<td>-0.16</td>
<td>0.062</td>
<td>0.104</td>
<td>-0.34 (-0.06)</td>
</tr>
<tr>
<td>Thornburg Better World International Fund</td>
<td>-8.10%</td>
<td>25.53%</td>
<td>-0.32</td>
<td>0.038</td>
<td>0.097</td>
<td>-1.73 (-0.38)</td>
</tr>
</tbody>
</table>