MEASURING THE FINANCIAL IMPACT OF COVID-19

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Stern Faculty Forum
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MEASURING THE FINANCIAL IMPACT OF COVID-19

• Stock market volatility around the world

• Bond market volatility

• Sector and commodity volatility

• Financial instability as measured by SRISK and other financial indicators

• Modeling the relation between infections and volatility
HOW DOES COVID-19 CRISIS COMPARE WITH THE GLOBAL FINANCIAL CRISIS?

• Completely different causes
• Optimal policies must therefore be very different
• Both have major spillovers to the real economy
• Stock market arguably values firms by their predicted present discounted cash flows so these spillovers can be compared.
• In the GFC, physical capital was wasted on overpriced housing. In the pandemic, human capital is being destroyed. Both take time and investment to recover.
CLIMATE CHANGE IMPACTS?

• Once the pandemic is over, the climate problem will still be here. However, we are losing time to transition to a low carbon economy.

• Much of the slowdown in social distancing reduces carbon emissions. Air and car transportation is way down. Industrial emissions are probably also down since only “essential” firms are operating.

• The drop in demand and boost in supply have driven oil prices to very low levels potentially eroding the cost advantage of renewables. It will lead to financial instability and fossil fuel sector bankruptcies.

• The subsidy legislation COVID III, has lots of bailout money for fossil fuel industries. This is a missed opportunity to invest in low carbon technology.

• This pandemic is from a zoonotic virus. With climate warming, such crises may become more frequent as animals migrate. Is this a “dress rehearsal?”
COVID-19 Case Study

Confirmed cases by country

Total cases: 417,966
Total deaths: 18,615

March 24th, 2020

See events (13)
HOW HIGH IS S&P VOLATILITY?

Notice that VIX < GARCH which is unusual since VIX includes volatility risk premium. Is the options market more optimistic than GARCH? Peak was 3/17/2020. Corona III signed on 3/27/2020.
HOW DOES THIS COMPARE WITH PAST EVENTS?
QUARTER YEAR RETURNS SP500

DOWN_QUARTER
DRAWDOWN = SPY/PEAKSPY-1

DRAWDOWN
HOW BAD CAN IT GET?

• Simulate volatility models using bootstrapped residuals thousands of times.
• Record the 1% quantile one month and one year ahead.
• This takes account of the skewness and kurtosis of the long horizon returns and incorporates the mean reversion in volatility
• We call this the Long Run Value at Risk
WHAT IS THE LONG RUN 1% VaR?
CRUDE OIL VOLATILITY IS FAR GREATER!
TOP VOLATILITIES TODAY

**Top Country Volatility**
- Brazil
- India
- Greece
- Canada
- United States
- Thailand
- Indonesia
- Italy
- Colombia
- Austria

**Global Industry Volatility**
- Energy
- Financials
- Real Estate
- Consumer Discretions
- Health Care
- Industrials
- Technology
- Basic Materials
- Telecommunications
- Utilities

**Top Currency Volatility**
- Russian Ruble
- Mexican Peso
- Norwegian Krone
- South African Rand
- Colombian Peso
- Indonesian Rupiah
- Brazilian Real
- Polish Zloty
- Czech Koruna
- Australian Dollar

**Top Commodity Volatility**
- Unleaded Gasoline Spot
- WTI Crude Oil
- All Crude Spot
- Petroleum Spot
- Brent Crude Oil
- Palladium Spot
- Energy and Metals Spot
- Heating Oil
- Lean Hogs
- BDI Baltic Exchange Dry
10 YEAR TREASURY VOLS

iShares 7-10 Year Treasury Bond ETF GJR-GARCH Volatility Analysis

Volatility Prediction for Monday, April 6th, 2020: 13.37% (-0.28%)

Graph showing annualized volatility over time with comparisons to the CBOT 10-Year U.S. Treasury Note Volatility Index Level.
IEF LONG RUN VaR
CORRELATIONS
COMMODITIES

GARCH-DCC-NL Correlation Between Commodities

Date: April 2020

Gold Spot Average Correlation: 0.1134
Average Correlation: 0.1546

Average Cross-Section Correlation

Jan 2019  Jul 2019  Jan 2020

DISTANCE: -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8
EQUITY SECTORS

Date: April 2020
S&P 500 Index Average Correlation: 0.8885
Average Correlation: 0.8127

[Graph showing correlation and distance for equity sectors]
INTERNATIONAL EQUITIES
EXCHANGE RATES

GARCH-DCC-NL Correlation Between Exchange Rates

- **Data:** April 2020
- **US Dollar to Singapore Dollar Average Correlation:** 0.4250
- **Average Correlation:** 0.2788

Chart showing the correlation between different currency pairs over time from January 2019 to January 2020.
SYSTEMIC RISK

SRISK is the capital a financial firm would need to raise in order to continue doing business if there is a 40% drop in the global equity market in the next six months. SRISK is often thought of as a bailout.
SRISK with and without CHINA
US SRISK, CAPACITY, and PROBABILITY
EUROPE SRISK
LOOK AT LEVERAGE OF EUROPEAN FINANCIALS

<table>
<thead>
<tr>
<th>Institution</th>
<th>SRISK %</th>
<th>↓ SRISK ($ m)</th>
<th>LRMES</th>
<th>Beta</th>
<th>Cor</th>
<th>Vol</th>
<th>Lvg</th>
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</thead>
<tbody>
<tr>
<td>BNP Paribas SA</td>
<td>7.77</td>
<td>111063.7</td>
<td>49.18</td>
<td>1.33</td>
<td>0.67</td>
<td>105.06</td>
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<td>Credit Agricole SA*</td>
<td>6.69</td>
<td>95703.9</td>
<td>47.81</td>
<td>1.27</td>
<td>0.61</td>
<td>103.22</td>
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<td>Societe Generale SA</td>
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<td>56.73</td>
<td>1.64</td>
<td>0.68</td>
<td>131.76</td>
<td>123.55</td>
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<td>HSBC Holdings PLC</td>
<td>5.16</td>
<td>73715.1</td>
<td>30.79</td>
<td>0.72</td>
<td>0.54</td>
<td>72.55</td>
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<td>Barclays PLC</td>
<td>4.96</td>
<td>70895.8</td>
<td>53.50</td>
<td>1.50</td>
<td>0.60</td>
<td>129.48</td>
<td>84.60</td>
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<tr>
<td>Deutsche Bank AG</td>
<td>4.94</td>
<td>70640.6</td>
<td>48.22</td>
<td>1.29</td>
<td>0.61</td>
<td>93.67</td>
<td>115.96</td>
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<td>Banco Santander SA</td>
<td>4.84</td>
<td>69255.2</td>
<td>45.78</td>
<td>1.20</td>
<td>0.65</td>
<td>90.96</td>
<td>43.78</td>
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<tr>
<td>Lloyds Banking Group PLC</td>
<td>3.15</td>
<td>45098.6</td>
<td>46.23</td>
<td>1.21</td>
<td>0.61</td>
<td>114.13</td>
<td>44.49</td>
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<tr>
<td>ING Groep NV</td>
<td>2.99</td>
<td>42725.1</td>
<td>52.96</td>
<td>1.48</td>
<td>0.60</td>
<td>121.34</td>
<td>49.04</td>
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<td>Royal Bank of Scotland Group PLC</td>
<td>2.87</td>
<td>41084.2</td>
<td>40.98</td>
<td>1.03</td>
<td>0.48</td>
<td>93.98</td>
<td>60.66</td>
</tr>
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</table>

RATIO OF DEBT TO EQUITY!!
## FIRST QUARTER CHANGES IN AMERICAS SRISK

**Systemic Risk Rankings for 2020-04-03**

<table>
<thead>
<tr>
<th>Institution</th>
<th>SRISK (t)</th>
<th>SRISK (t-1)</th>
<th>Δ SRISK</th>
<th>Δ DEBT</th>
<th>Δ EQUITY</th>
<th>Δ RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citigroup Inc</td>
<td>106818.9</td>
<td>66267.2</td>
<td>40551.6</td>
<td>-4818.8</td>
<td>42288.7</td>
<td>3091.7</td>
</tr>
<tr>
<td>Wells Fargo &amp; Co</td>
<td>83523.1</td>
<td>16386.9</td>
<td>67136.1</td>
<td>-817.2</td>
<td>63758.9</td>
<td>4194.4</td>
</tr>
<tr>
<td>Bank of America Corp</td>
<td>81289.1</td>
<td>77514</td>
<td>3578.7</td>
<td>989.8</td>
<td>74499.2</td>
<td>-1951.4</td>
</tr>
<tr>
<td>JPMorgan Chase &amp; Co</td>
<td>66385.0</td>
<td>-18202.7</td>
<td>84587.7</td>
<td>-5930.6</td>
<td>88655.4</td>
<td>1863.0</td>
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<tr>
<td>Goldman Sachs Group Inc/Inc/</td>
<td>47072.4</td>
<td>35676.0</td>
<td>11396.4</td>
<td>-1002.2</td>
<td>14738.4</td>
<td>-2339.8</td>
</tr>
<tr>
<td>Prudential Financial Inc</td>
<td>43915.3</td>
<td>33083.5</td>
<td>10831.8</td>
<td>551.4</td>
<td>8749.8</td>
<td>1530.5</td>
</tr>
<tr>
<td>Toronto-Dominion Bank/The</td>
<td>42334.5</td>
<td>20557.5</td>
<td>21771.0</td>
<td>2205.4</td>
<td>17402.5</td>
<td>2469.1</td>
</tr>
<tr>
<td>Morgan Stanley</td>
<td>40254.6</td>
<td>30059.5</td>
<td>10195.0</td>
<td>-496.6</td>
<td>12665.0</td>
<td>-1973.4</td>
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<tr>
<td>Bank of Nova Scotia/The</td>
<td>37602.8</td>
<td>17753.5</td>
<td>19849.3</td>
<td>2463.7</td>
<td>12628.7</td>
<td>4755.5</td>
</tr>
<tr>
<td>Royal Bank of Canada</td>
<td>36674.0</td>
<td>10262.5</td>
<td>26411.5</td>
<td>3015.5</td>
<td>17620.2</td>
<td>5775.7</td>
</tr>
</tbody>
</table>
WHAT EXPLAINS ALL THIS VOLATILITY?  THE VIRUS!!

THANKS TO SILA ALAN AND AHMET KARAGOZOGLU FOR LOTS OF HELP WITH THIS.
LOG CASES - EIGHT COUNTRIES
THREE REGIMES

• SLOW GROWTH

• RAPID GROWTH

• CONCAVE GROWTH LEADING TO A PEAK

• REGIME CHANGES ARE QUITE VARIABLE
LOG CASES – MORE COUNTRIES
DVOL(T) = GJRGARCH(T) - JANUARY FOR EIGHT COUNTRIES
RETURNS YTD

![Graph showing returns YTD for different countries from 2020-01-01 to 2020-04-02](chart.png)
A PRELIMINARY MODEL

• AT EACH TIME T, CALCULATE
  • CASES=LOG CONFIRMED CASES+1,
  • INFECTION RATE= [CASES(T)-CASES(T-14)], AND
  • CURVATURE= [CASES(T)+ CASES(T-14)-2*CASES(T-7)]

• REGRESS DVOL ON CASES, INFECTION RATE, CURVATURE
  • WITH TIME FIXED EFFECTS
  • WITH SPILLOVERS FROM US
### Panel of DVOL from Feb 3 to April 3, 2020

![Table showing model results]

**Model:**

\[ DVOL_{janmean} = b(1) \log(Cases[t]) + b(2) \text{InfectionRate}[t] + b(3) \text{Curvature}[t] + \text{const} \]

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Model 4 (GLB)</th>
<th>Model 4 (TFE)</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Cases[t-1]</code></td>
<td>3.434</td>
<td>4.649</td>
</tr>
<tr>
<td></td>
<td>[2.88]***</td>
<td>[3.91]***</td>
</tr>
<tr>
<td><code>Infection Rate[t-1]</code></td>
<td>1.913</td>
<td>-0.082</td>
</tr>
<tr>
<td></td>
<td>[2.07]**</td>
<td>[-0.10]</td>
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<tr>
<td><code>Curvature[t-1]</code></td>
<td>1.158</td>
<td>0.248</td>
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<tr>
<td></td>
<td>[2.51]**</td>
<td>[0.58]</td>
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<tr>
<td><code>LogUSA_Cases[t-1]</code></td>
<td>-1.148</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-1.35]</td>
<td></td>
</tr>
<tr>
<td><code>USA_Infection Rate[t-1]</code></td>
<td>8.158</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[13.52]***</td>
<td></td>
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<tr>
<td><code>LogGlobalCases[t-1]</code></td>
<td></td>
<td>-3.676</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-1.36]</td>
</tr>
<tr>
<td><code>Global Infection Rate[t-1]</code></td>
<td></td>
<td>-4.229</td>
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<tr>
<td></td>
<td></td>
<td>[-7.21]***</td>
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<tr>
<td><strong>Intercept</strong></td>
<td>-4.194</td>
<td>-0.504</td>
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<tr>
<td></td>
<td>[-1.54]</td>
<td>[-0.33]</td>
</tr>
</tbody>
</table>

**Time Fixed Effects**

- No: Model 4 (GLB)
- Yes: Model 4 (TFE)

**Statistics**

- **R-Sq-within**: 0.577 (Model 4 (GLB)), 0.543 (Model 4 (TFE)), 0.659
- **R-Sq-between**: 0.256 (Model 4 (GLB)), 0.234 (Model 4 (TFE)), 0.218
- **N**: 3506 (Model 4 (GLB)), 3506 (Model 4 (TFE))

**Note:** GLB is Global Cases & Global Infection Rates. TFE is time fixed effects.
YTD RETURN FROM FEB 3 TO APRIL 3, 2020

Model:
\[ \text{RET\_YTD} = b(1)\text{LogCases}[t] + b(2)\text{InfectionRate}[t] + b(3)\text{Curvature}[t] + \text{const} \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 4</th>
<th>Model 4 (GLB)</th>
<th>Model 4 (TFE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[-3.46]***</td>
<td>[-5.39]***</td>
<td>[-4.07]***</td>
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<tr>
<td>Infection Rate[t-1]</td>
<td>-0.548</td>
<td>-1.204</td>
<td>0.235</td>
</tr>
<tr>
<td></td>
<td>[-1.19]</td>
<td>[-2.23]**</td>
<td>[0.55]</td>
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<tr>
<td>Curvature[t-1]</td>
<td>-0.016</td>
<td>-0.171</td>
<td>0.389</td>
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<td></td>
<td>[-0.08]</td>
<td>[-0.67]</td>
<td>[2.03]**</td>
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<tr>
<td>LogUSA_Cases[t-1]</td>
<td>-0.207</td>
<td>-0.45</td>
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<tr>
<td></td>
<td>[-0.45]</td>
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<td>USA_Infection Rate[t-1]</td>
<td>-3.879</td>
<td>[-11.99]***</td>
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<td>LogGlobalCases[t-1]</td>
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<td>[-0.52]</td>
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<tr>
<td>Global Infection Rate[t-1]</td>
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<td>1.555</td>
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<tr>
<td></td>
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<td>[5.33]***</td>
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<tr>
<td>Intercept</td>
<td>6.768</td>
<td>8.138</td>
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<td></td>
<td>[5.05]***</td>
<td>[0.50]</td>
<td>[3.49]***</td>
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<tr>
<td>Time Fixed Effects</td>
<td>No</td>
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<td>Yes</td>
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<tr>
<td>R-Sq-within</td>
<td>0.733</td>
<td>0.687</td>
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<td>R-Sq-between</td>
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<td>N</td>
<td>3506</td>
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NOTE: GLB is GlobalCases & Global Infection Rates. TFE is time fixed effects
STRINGENCY INDEX FROM OXFORD
DISCUSSION

• If this is a stable and structural relation, then policies to stabilize the infection and rate of increase of infection will reduce stock market volatility and put upward pressure on the market.

• I find that several other variables such as population, deaths and other dynamics do not change the results and are generally insignificant.

• More stringency in policy increases volatility and time since the epidemic started decreases it. Of course, stringency may be a function of cases itself.
CONCLUSIONS

• Volatility measures are as high as during the Great Depression and higher than the Global Financial Crisis.
• The drawdown has not been as great as either GFC or Internet bubble. (so far)
• Correlations are rising
• Systemic risk is rising
• Financial impact is found to be correlated with the log of confirmed cases. If policies can keep these down, the stock market may improve.
What is in their future?