FNA

Correlation Networks

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Transactions & Similarity Based Networks

**Transaction**: payment, trade, exposure, supply, flow, ...

**Similarity**: correlation, partial correlation, granger causality, transfer entropy, ...

Stavroglou et al (2016)

*Causality Networks of Financial Assets*
Interconnectivity of markets has increased

We need to be able to understand correlations structures of much larger scale.

Networks help develop intuition, and understand stress tests.
Typical view of cross asset correlations

![Correlation Matrix Over the Last 15 Years (2001-2015)](#)
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<th>Description</th>
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<tbody>
<tr>
<td>BND</td>
<td>Total Bond Index</td>
<td>FXC</td>
<td>CAD</td>
<td>USO</td>
<td>Oil</td>
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<td>Commodities</td>
<td>FXE</td>
<td>EUR</td>
<td>UUP</td>
<td>USD Index</td>
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<td>FXI</td>
<td>China</td>
<td>VGK</td>
<td>Europe</td>
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<tr>
<td>DXJ</td>
<td>Japan Stocks (in JPY)</td>
<td>FXY</td>
<td>JPY</td>
<td>VPL</td>
<td>Asia</td>
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<td>EEM</td>
<td>Emerging Markets</td>
<td>GDX</td>
<td>Gold Miners</td>
<td>VXX</td>
<td>VIX ST Futures</td>
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<td>EFA</td>
<td>EAFE</td>
<td>GLD</td>
<td>Gold</td>
<td>XIU</td>
<td>TSX 60</td>
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<td>EMBI</td>
<td>IEF</td>
<td>Barclays 1-7Y US</td>
<td>XLB</td>
<td>Materials</td>
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<td>Asia ex Japan</td>
<td>IYR</td>
<td>Real Estate</td>
<td>XLE</td>
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<td>Germany</td>
<td>JNK</td>
<td>High Yield Bonds</td>
<td>XLF</td>
<td>Financials</td>
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<td>Italy</td>
<td>LQD</td>
<td>Corp Bonds</td>
<td>XLK</td>
<td>Tech</td>
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<tr>
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<td>Japan</td>
<td>SLV</td>
<td>Silver</td>
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<td>France</td>
<td>SPY</td>
<td>S&amp;P 500</td>
<td>CSJ</td>
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<td>UK</td>
<td>TIP</td>
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<td>FXF</td>
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<td>GBP</td>
<td>TLT</td>
<td>20Y+ Gov’t</td>
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</table>
Correlation Network of the Assets

We can view any matrix as a network.

We encode correlations as links between the correlated nodes/assets.

Red link = negative correlation
Black link = positive correlation

However, this simple encoding does not give us much.
Not all correlations are statistically significantly different from 0.

Absence of link marks that asset is not significantly correlated (here at 95% level).

Due to the large number of estimates, we also need for multiple comparisons correction. Eg. Bonferroni or FDR.
Network Layout

We can use network layouts to better detect patterns from noise.

E.g. we can try a Force-Directed network layout to identify clusters.
Next, we identify the Minimum Spanning Tree and filter out other correlations (Mantegna, ‘99).

We need a distance function, here we look at maximum spanning tree with distance function: abs(cor)

This shows us the backbone correlation structure.
We use a radial tree layout algorithm (Bachmeier et al. ‘05) that places the assets so that:

- Shorter links in the tree indicate higher correlations
- Longer links indicate lower correlations

As a result, we also see how the assets cluster by asset class.
Radial Tree Layout

Focus on the links in the Spanning Tree to highlight clustering structure.

Node color indicates last daily return

- Green = positive
- Red = negative

Node size indicates magnitude of return

Bright colors are VaR exceptions
Often networks are large and complex and we want to filter out noise. Filtering techniques give solutions.

Researchers are using network analytics and advanced data modeling to identify weak spots in the system that otherwise might go unnoticed.
In this example we look at US house prices across states. We see the US states as nodes and strong correlation between house prices as link. In 2000 the tree is very spread out and prices are going slightly up. This is a time when ABS are developed with the assumption that real-estate risk can be diversified across US states.
In 2003 we start to see some strong upward movements in prices in states like Nevada and we see a big cluster of bumper returns in Florida and states that have strong correlations with it.
As we move into 2004, into the peak of the housing bubble we see that most states now have outlier price changes and Nevada for example has an almost 12% rise in house prices in one quarter.
As we move into 2005 we look at the length of the tree. It measures the overall correlations in this system. The shorter (smaller value) the tree, the stronger the correlations. We see that the tree has been getting shorter and shorter. The assumptions behind diversification of ABS getting eroded.
In summer 2007 the housing bubble is over and we see the first negative outlier in Florida. Most of the system has become red, except a green branch on the left.

We also see that the tree has been getting shorter and shorter, reaching new lows each quarter. The system is becoming highly coupled.
In 2009 we reach the peak crisis. The system has become largely red with many central states as negative outliers.

We can look at another metric on the left. Systematic risk measures how much changes in the system are driven by the largest single factor, and how much by idiosyncratic - state level - factors. We see that the system is quickly becoming governed by a single factor affecting all states.
The same dynamics continue with the "double dip" in 2011.
In Spring 2012 we see the first positive outlier in North Dakota, likely drive by the fracking boom. The rest of the system is still mostly negative.
If we fast forward to the latest observation, July 2015, we see a period of positive changes in prices with outliers scattered across the network.

We also see both systematic risk and correlations at their peak. We have not returned to the pre-bubble system state but are in a very risky territory still.
We can see this clearly by looking at the size of the tree.

First in 2010.
Then at the peak of the bubble in 2005.
Then at the peak of the crisis in 2009.
And now.
The tree has shrunk during the whole period. The correlations are now stronger than ever.

Such slow moving change is hard to notice when focusing on daily events. Like in the story of the frog put in water that is gradually heated.
Welcome to the 2016 US Presidential Election Tour

We are delighted to guide you through this dashboard tour, which will only take two minutes. In order to revisit the tour at anytime, click the Tour icon.

Next
Day Before the Election
Let's move to the 7th of November 2016, the day before US presidential election.
Day Before the Election

...and strong negative movements in ‘flight to safety’ assets such as Japanese Yen and Gold.
Day of the Election

On the day of the vote, as exit polls started to come in, markets were relatively calm. How to interpret Trump winning the presidency and Republicans taking the congress?
Day After the Election

Let's find it out by moving forward of one day.
Day After the Election

On the day after the vote, the markets had made their mind and we see three strong clusters. Most US equity markets such as Materials and Financial have heavy gains with promises to repeal the Dodd-Frank Act and $1T worth of new infrastructure spending.
Day After the Election
On the downside, we see strong negative movements in the markets for the rest of the world equity markets. A result of 'America First'. We also see strong negative movements in US and other bond prices as the third cluster.
Day After the Election

We also see strong negative movements in US and other bond prices as the third cluster.
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