FINANCIAL NETWORKS

AP

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INTRODUCTION

Theme: discover a relationship among traded shares (equity)

look at historical market data to see whether price variations relate to each other.

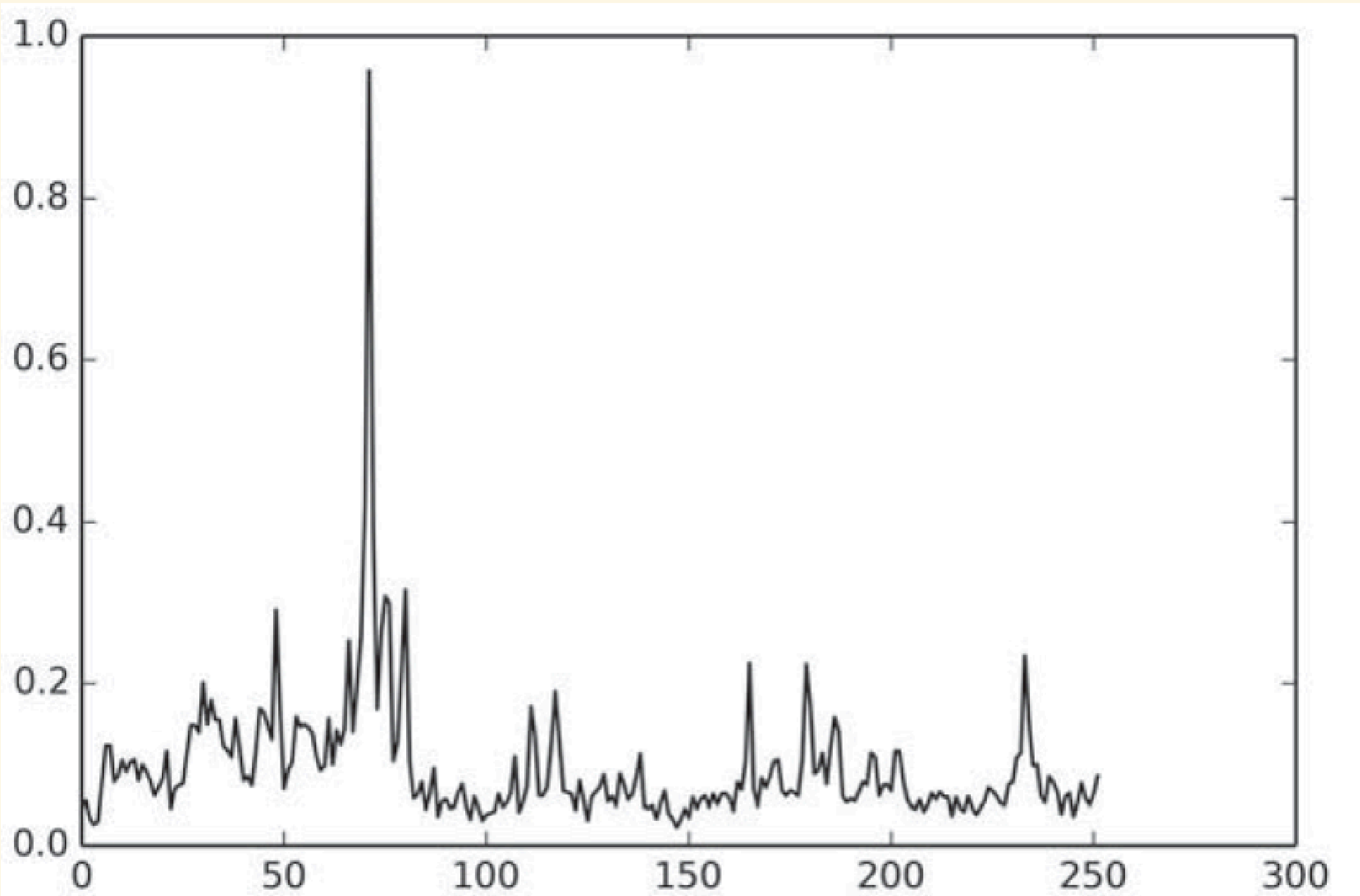
Are there *regularities* that could anticipate the future behaviour of price?

In Food Networks (Ch. 1) we discovered a regularity:

$$\frac{\#pred}{\#prey} \approx 1$$

IMPORTANT ASSUMPTION

When markets are *calm*, investment becomes somewhat `mathematical'



PRICE TIME SERIES

PROPORTIONAL RETURN ON INVESTMENT

- depends on time
- essentially, the discrete counterpart of the time derivative of price:

$$r(\Delta t) = \frac{p(t_0 + \Delta t) - p(t_0)}{p(t_0)}$$

$$r(\Delta t) = \frac{p(t_0 - \Delta t) - p(t_0)}{p(t_0)}$$

in the limit $\Delta t \to 0$ it can be rewritten:

$$r(t) \simeq \frac{d \ln p(t)}{dt}$$

For discrete time:

$$r = \ln p(t_0 + \Delta t) - \ln p(t_0)$$

CORRELATION OF PRICES

- correlations in time series (or simply *comovements*) are valuable indicators
- Two shares are correlated if historically their price varied *in a similar way*.
- To qualify such a relation compute the correlation between their price returns over Δt.

Let $\langle r_i \rangle$ be the average return of *i* over Δt

$$\rho_{ij}(\Delta t) = \frac{\langle r_i r_j \rangle - \langle r_i \rangle \langle r_j \rangle}{\sqrt{(\langle r_i^2 \rangle - \langle r_i \rangle^2)(\langle r_j^2 \rangle - \langle r_j \rangle^2)}}$$

- high ρ's might uncover hidden links between stocks.
- however, monitoring $n(n-1)$ correlations quickly becomes unfeseable
- we focus on high ρ values.

THE SPANNING TREE OF STOCKS

SIMILAR-BEHAVIOUR SHARES

Correlation (or lack of it) induces a *distance* b/w shares:

$$d_{ij}(\Delta t) = \sqrt{2(1 - \rho_{ij}(\Delta t))}$$

Let $D(\Delta t)$ be the complete matrix of pairwise distances:

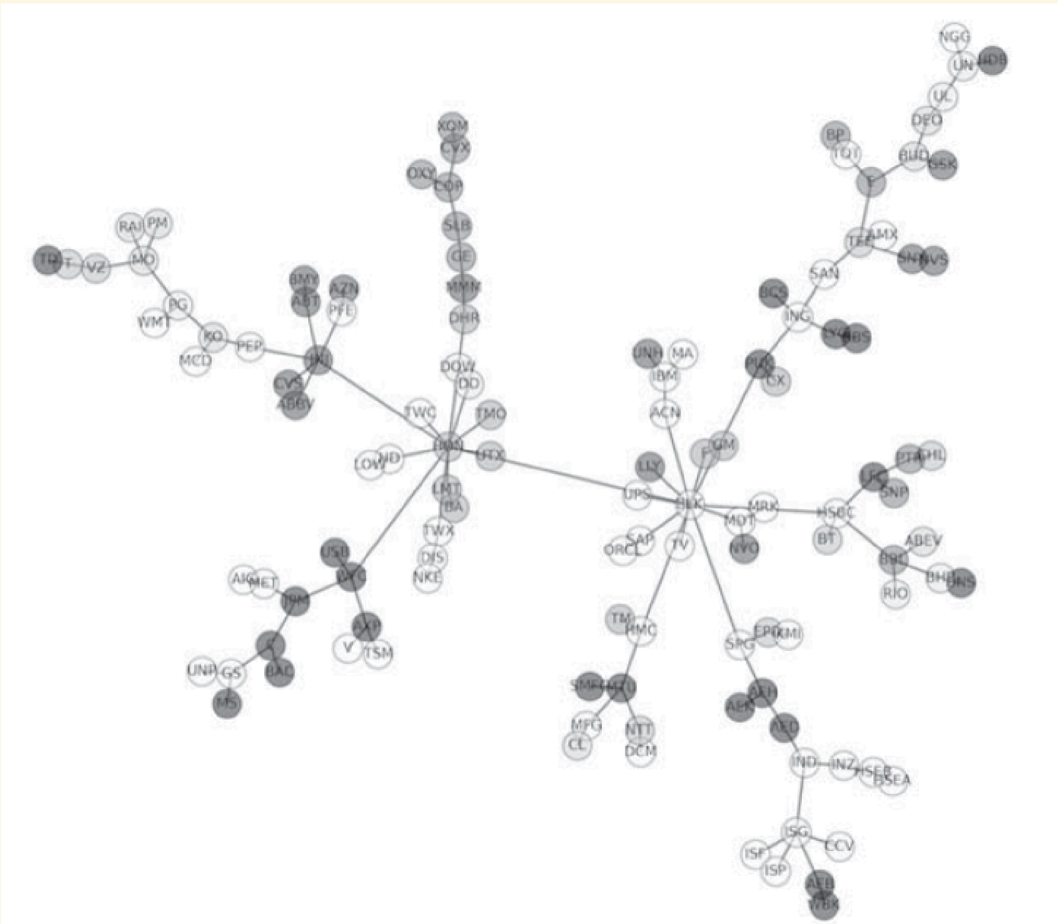
it describes a complete, weighted network!

Prune it to create its Mimimum Spanning Tree (MST)

The MST has only n-1 *heavy* connections while maintaining connectivity.

RESULTING MODEL

The MST of 141 NYSE high-cap stocks, $\Delta t = $ 6h:30min



Some shares are *hubs* for local clusters of highly-correlated shares.

CONSEQUENCES

- Network analysis helps indentifying local clusters
- Each clusters will have a *hub share* at its center
- Hub shares can *signal* the beaviour of the whole cluster:
- they provide leads in forecasting how sections of the market will move.