BIG DATA STATISTICS FOR BUSINESS

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Identifying influencers in a social network

- Customers are crucial assets for a firm but they can be costly to acquire.

- The issue of customer acquisition is of utmost importance to any organisation. Ensuring the inflow of customers to be larger than the outflow so that the customer base increases is not at all straightforward.

- Therefore, marketers are in a continuous battle for attracting potential customers' attention.

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- Many companies have shifted part of their marketing efforts from directly communicating with potential customers to incentivizing existing customers to do so (e.g. communications between people).

- This is driven by the growing acceptance of the fact that people are highly influenced by information received from others and that word-of-mouth (WOM) is the most influential source of information to a customer.

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- A particular subset of consumers may have greater value to firms because they have a high propensity to propagate product information, because:

1. they are particularly influential

2. they have more friends

- Firms should want to find these influencers and promote useful behavior.

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- This approach is innovative with respect to the traditional marketing approaches assuming that consumers act independently.
- Traditional statistical methods collect many predictors on each actor (e.g.: income, age, shopping habits) and use in multivariate models such as regression.

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- In contrast, referral marketing (or network-based marketing) assumes interdependency among consumers.
- When interdependencies exist, it may be beneficial to measure and account for.

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Referral marketing

- Referral marketing is a form of advertising in which companies encourage customers to recommend their services, products, or experiences to other people.

- Empirical research has confirmed that consumers rely on the advice of others in their personal network (WOM) when making purchase decisions.

- In general, positive WOM has a positive effect on sales.

- Referral marketing has become an important marketing technique for acquiring new customers (Roelens et al., 2016).

- It has been estimated that social influence can greatly decrease the costs of acquiring new customers.

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- A good example of referral marketing success is Dropbox.

- The company managed to expand their customer base from 100,000 to 4 million users in a 15-month period by leveraging the power of referrals.

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- Suppose a company has data on the social network of its customers, in which the interactions give an indication of how influence flows between the individuals.

- If the company wants to attract as many new customers as possible by relying on the power of social influence, it can initially target only a few individuals who are expected to influence friends who, in turn, will recommend the product to other friends.

- The key question is how to select those initial influencers who will seed this process.

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- In literature, selecting a group of individuals who are most likely to generate the largest cascade of influence through WOM is also known as the influence maximization problem

- Customer referral programs encourage existing customers to recommend a firm's services or products to their network.

- They aim to provoke cascades of word-of-mouth.

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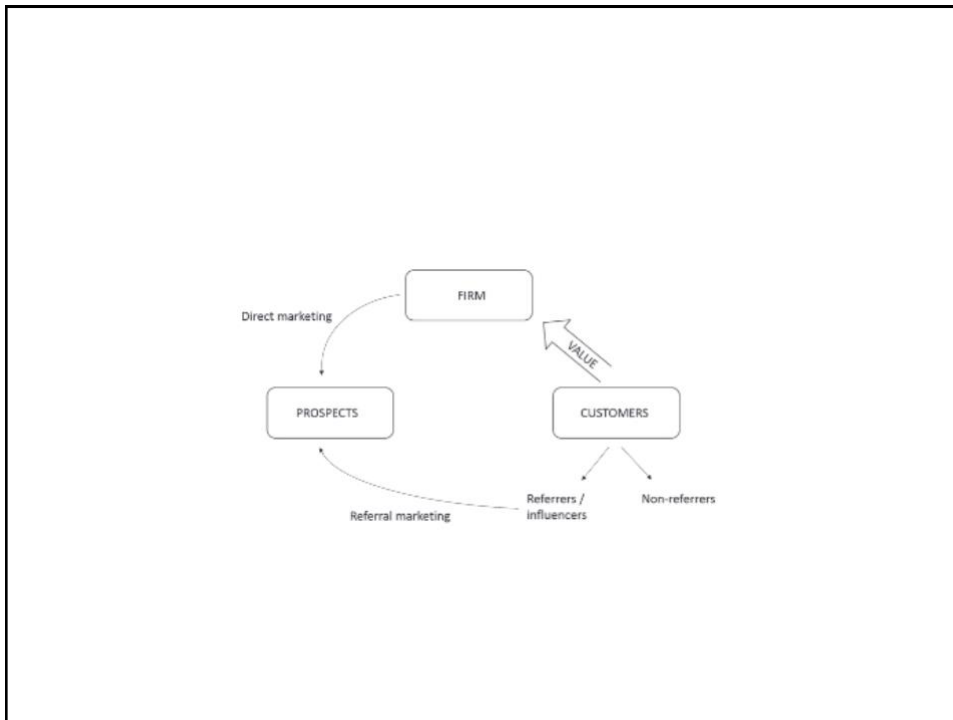
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- Villanueva et al. (2008) show that customers who joined the firm as a result of WOM recommendations of social connections add almost twice as much long-term value to the firm than other customers.

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- Villanueva et al. (2008) show that customers who joined the firm as a result of WOM recommendations of social connections add almost twice as much long-term value to the firm than other customers.

- Kumar et al. (2010) show that the most valuable customers are not always those who buy most, but those whose WOM attracts the most profitable new customers.

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- Many companies have already understood this and referral programmes now exist in many industries such as telecommunication, retail, energy providers,…

- The number of referral marketing programmes is expected to increase significantly as a result of the rise in social media usage, and the growing number of online platforms to outsource referral programmes.

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- Customers and prospects influence each other through WOM and in that sense we can think of forming a network G(V,E) in which the individuals (customers and/or prospects) represent the nodes V and the relationships between the individuals form the edges E.

- This representation allows for graph analysis of customer activities. The influence maximization problem identifies a group of customers that leads to the largest influence spread in the social network.

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- To estimate influencers we can use one of the network measures defined for each node:
1. Degree
2. Closeness (centrality)
3. Betweenness (centrality)

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Online social network

- Online social networks have become an essential medium for social interactions and information sharing among users.
- Electronic word-of-mouth (eWOM) refers to the sharing of opinions, experiences, and recommendations about products and services through online platforms.

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Online social network

- Research suggests that individuals with higher <u>centrality</u> are more likely to engage in eWOM activities as they possess greater social capital and influence.
- Social network <u>density</u>, on the other hand, refers to the extent to which connections exist within a network.
- Higher network density facilitates the flow of information, making it easier for eWOM messages to spread.
- Social network usage is strongly influenced by social network centrality and density.

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WOM and eWOM

- There is a notable difference between the concepts of WOM and eWOM.
- WOM is based on the credibility between two participants who know each other a priori
- In the case of eWOM, the interaction takes place between participants who know each other very little or not at all.

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eWOM

- We can distinguish:
1. Positive eWOM
2. Negative eWOM

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Positive eWOM

- Positive eWOM refers to positive comments, reviews, recommendations, and other forms of electronic communication that consumers share about products or services through social media platforms.
- Some common characteristics of positive eWOM include:
1. Authenticity
2. Reach
3. Engagement
4. Permanence

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Positive eWOM

- Authenticity
- Positive eWOM is often seen as more authentic than traditional advertising, as it comes from real people who have used the product or service.
- Consumers are more likely to trust recommendations from their peers than traditional advertising.

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Positive eWOM

- Reach
- Positive eWOM has the potential to reach a large audience, as it can be shared and amplified through social media platforms and other online channels.

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Positive eWOM

- Engagement
- Positive eWOM can lead to engagement and interaction between consumers and brands, as consumers may respond to or share positive comments about a product or service.

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Positive eWOM

- Permanence
- Positive eWOM can have a long-lasting impact, as it can remain online for an extended period of time and be accessed by future consumers.

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Positive eWOM

- Positive e-WOM is not always genuine.
- Companies may create fake positive reviews to manipulate consumer perception (*astroturfing*).
- This can ultimately backfire and harm the brand's reputation.
- Therefore, it is important for companies to encourage genuine positive e-WOM.

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Positive eWOM

- Summarizing, positive e-WOM is a form of online communication where consumers share their positive experiences with a particular product, service, or brand. It is a powerful tool that can significantly influence consumer behavior and drive sales.

- One of the main benefits of positive e-WOM is that it can increase brand awareness and attract new customers.

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Negative eWOM

- Negative e-WOM refers to the online communication of negative or unpleasant experiences with a particular product, service, or brand.

- It is a form of negative feedback that can affect a company's reputation and, ultimately, its sales.

- People believe that their negative feedback can help other consumers make a better decision By sharing their negative experience, they hope to prevent other consumers from making the same mistake.

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Negative eWOM

- Some studies showed that an increase in negative feedback can lead to a significant decrease in sales.

- Negative feedback can affect a company's reputation and lead to a loss of consumer trust in its product or service.

- There are several ways in which companies can manage negative feedback online. One of these is to respond to feedback and try to address the issues raised by consumers.

- Companies must consider negative feedback and try to manage it effectively in order to protect their reputation and maintain consumer trust in the brand.

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Research questions

- Does Social Network Centrality have a significant influence on Positive eWOM Intention?

- Does Social Network Centrality have a significant influence on Negative eWOM Intention?

- Does Social Network Density have a significant influence on Positive eWOM Intention?

- Does Social Network Density have a significant influence on Negative eWOM Intention?

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References

- For the WOM:
- **Villanueva, Yoo, Hanssens.** The Impact of Marketing-Induced versus Word-of-Mouth Customer Acquisition on Customer Equity Growth. Journal of Marketing Research
- **Kumar, Petersen, Leone (2010).** Driving profitability by encouraging customer referrals: who, when, and how. Journal of Marketing

- For the eWOM and the above research questions:
- **Anastasiei, Dospinescu, Dospinescu,** *Word-of-Mouth Engagement in Online Social Networks: Influence of Network Centrality and Density,* Electronics*, 2023*

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Network in finance

- The Financial Crisis of 2007–2009 has created renewed interest in systemic risk, a concept originally associated with bank runs and currency crises, but which is now applied more broadly to shocks in any part of the financial system.

- By definition, systemic risk involves the financial system, a collection of interconnected institutions that have mutually beneficial business relationships through which illiquidity, insolvency, and losses can quickly propagate during periods of financial distress.

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- To capture this connectedness there are some statistical methods, in particular:
- principal components analysis
- Granger-causality networks

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Granger-causality networks

- The Granger-causality method implies to use pairwise Granger-causality tests to identify the network of (significant) relations among the institutions.

- Empirical findings show that linkages within and across financial assets are highly dynamic, varying in quantifiable ways over time and as a function of market conditions.

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- The study by Billio et al. (2012) focus on four sectors (four types of financial institutions):
- Hedge funds
- Publicly traded banks
- Broker/dealers
- Insurance companies
- For each sector monthly returns of the 25 largest companies have been considered.

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- To investigate the dynamic propagation of shocks to the system, it is important to measure not only the degree of connectedness between financial institutions, but also the directionality of such relationships.
- Directed network.

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- Granger-causality tests also point to an important asymmetry in the connections: e.g. the returns of banks and insurers seem to have more significant impact on the returns of hedge funds and broker/dealers than viceversa.
- Directed and weighted network.

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Granger causality

- The study uses Granger causality, a statistical notion of causality based on the relative forecast power of two time series.

- Return time series R^j is said to''Granger-cause'' time series R^i if past values of R^j contain information that helps predict R^i above and beyond the information contained in past values of R^i alone.

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Statistical formulation

- The statistical formulation of this test is based on linear regressions of R^i_{t+1} on R^i_t and R^j_t and of R^j_{t+1} on R^j_t and R^i_t

- We can represent their linear inter-relationships with the following model with two equations

- $R^i_{t+1} = k_i + a_i R^i_t + b_{ij} R^j_t + e$

- $R^j_{t+1} = k_j + a_j R^j_t + b_{ji} R^i_t + e$

- The crucial coefficients of the model are b_{ij} and b_{ji}.

- R^j Granger-causes R^i when b_{ij} is significantly different from zero.

- R^i Granger-causes R^j when b_{ji} is significantly different from zero.

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- When both of these statements are true, there is a feedback relationship between the time series.
- In an informationally efficient financial market, short-term asset-price changes should not be related to other lagged variables: a Granger-causality test should not detect any causality.
- However, in the presence of market frictions such as transactions costs, costs of gathering and processing information, and institutional restrictions on shortsales, we may find Granger causality among price changes of financial assets.

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- Therefore, the degree of Granger causality in asset returns can be viewed as a proxy for return spillover effects among market participants.
- Billio at al. (2012) proposed some Granger-causality measure of connectedness to capture the lagged propagation of return spillovers in the financial system, i.e., the network of relations among financial institutions.

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Indicator of causality

- The following indicator of causality is defined:

$$(j \rightarrow i) = \begin{cases} 1 & \text{if } R^j \text{ Granger} - \text{cause } R^i \\ 0 & \text{otherwise} \end{cases}$$

- These indicator functions may be used to define the connections of the network of *N* financial institutions, from which we can then construct some network-based measures of connectedness.
- In this study N=100.

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Degree of Granger causality

- The degree of Granger causality (DGC) is the number of statistically significant Granger-causality relationships among all *N*(*N*-1) pairs of *N* financial institutions

$$DGC = \sum_i \sum_j (j \rightarrow i)$$

- The risk of a systemic event is high when DGC is high.

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Number of pair connections

- To assess the systemic importance of single institutions, we define two simple counting measures.
- $In-$ degree measures the number of financial institutions that significantly Granger-cause institution j:

$$In(S \rightarrow j) = \sum_{i} (i \rightarrow j)$$

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Number of pair connections

- $Out-$ degree measures the number of financial institutions that are significantly Granger-caused by institution j:

$$Out(j \rightarrow S) = \sum_{i} (j \rightarrow i)$$

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- Results: the Granger-causality relationships are highly dynamic among these financial institutions.

- The total number of connections between financial institutions was 583 at the beginning of the sample 1994–1996 (6% of all possible connections).

- It more than doubled to 1244 at the end of the sample 2006–2008 (13% of total possible connections).

- The financial system becomes much more interconnected in comparison to more tranquil periods.
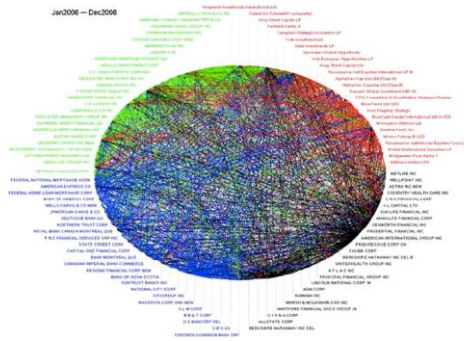
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Network edges: years 1994-1996
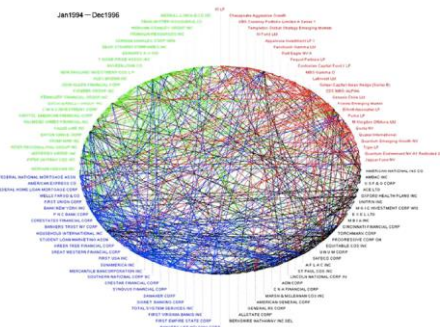
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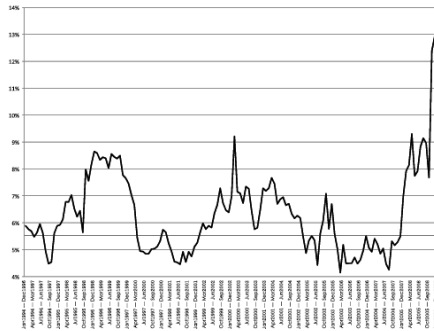
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Network edges: years 2006-2008

Color: green for broker/dealers, red for hedge funds, black for insurers, and blue for banks

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Network density over time

Number of connections as a percentage of all possible connections

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References

- **Billio, Getmansky, Lo, Pelizzon.** Econometric measures of connectedness and systemic risk in the finance and insurance sectors. Journal of Financial Economics

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