Do Online Social Networks Increase Welfare?

Manuel Mueller-Frank (joint with Mallesh Pai)

IESE Business School

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Introduction

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- What happens on online social networks?
  - Users generate vast amounts of information
  - Facebook daily average: 4.5 billion "likes", 5 billion shared items, 350 million pictures
  - Average user’s friends generate: 712 "likes", 790 shared items, 55 pictures daily
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What are the objectives and incentives of OSNs?
The main revenue source of OSNs is advertising
- 92% in case of Facebook
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We model an online social network as strategic agent with own incentives.

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Introduction: Approach and Main Question

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- OSN enable social learning and hence might increase welfare
Introduction: Approach and Main Question

- In literature the network is typically modeled as inert conduit
- We model an online social network as strategic agent with own incentives
- **Question:** How do financial incentives of OSNs affect social information flows and social welfare?
  - OSN enable social learning and hence might increase welfare
  - But OSN might distort information towards more lucrative but welfare inferior outcomes
Two firms $j = 1, 2$

- each firm offers a product with quality $q_j$ drawn iid from $[0, 1] = Q$
- Realized qualities known to firms, unknown to consumers
The Model: Firms and Consumer

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  - Select highest quality product among those sampled
  - Utility is given by quality of chosen product minus search costs
There are two types of consumers

- Mass 1 of early movers
- Mass $\lambda$ of late movers
The Model: The Online Social Network

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- All consumers are active on an OSN
  - Each early consumer announces on the OSN the product he purchased

Organic virality:
With probability $v_B$, each late consumer independently observes the purchases of $k = 1$ uniformly drawn early consumer. Late consumers update their belief over $Q_2$ rationally.
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After observing their qualities firms simultaneously select their banner advertising expenditures $m_1^d$, $m_2^d$. 
The Model: Banner Advertising

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- Consumers rationally update their beliefs according to the display ad they have seen
**Sponsored virality:** With probability \((1 - \nu_B)\nu_S\) each late consumer independently observes the purchase of \(k = 1\) early consumer.

Social advertising allows firms to bias what late movers see.
The Model: Social Advertising

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  - Let \(\phi_j\) be the measure of early consumers that bought product \(j\).
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- Firms simultaneously select their social advertising expenditures \(m_1^s\), \(m_2^s\).
  - Let \(\phi_j\) be the measure of early consumers that bought product \(j\).
  - Conditional on observing a social ad, each late mover observes a purchase of product 1 independently with probability

\[
\frac{\phi_1 m_1^s}{\phi_1 m_1^s + \phi_2 m_2^s}
\]
OSN selects $v_B, v_S$ and $k$

Product qualities realized, revealed to firms
The Model: Timing

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1. OSN selects $v_B$, $v_S$ and $k$
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3. Firms simultaneous choose $m^d_j$, $m^s_j$
4. Early movers see display ads, sample and select a product
5. Late movers see display ads, might see early movers choice, sample and select product
Proposition 1: In every equilibrium both firms spend the same amount on banner advertising

\[ m_1^d(q, v_B, v_S) = m_2^d(q, v_B, v_S). \]
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**Theorem**

*In every equilibrium expected social welfare is strictly increasing in the baseline virality. If the equilibrium advertising expenditures are positive, then expenditures are strictly decreasing in the baseline virality.*
**Proposition 2:** In every equilibrium both firms spend the same amount on banner advertising and social advertising

\[
\begin{align*}
m_1^d(q, v_B, v_S) &= m_2^d(q, v_B, v_S) \\
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Expected social welfare is strictly increasing in the fraction \( v_B + (1 - v_B)v_S \) of late consumers that receive social information.
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**Theorem**

*In every equilibrium total advertising revenue is decreasing in \( v_B \). Total advertising revenues are maximized at either \((v_B, v_S) = (0, 0)\) or \((v_B, v_S) = (0, 1)\) depending on \((F_Q, F_C)\).*
Extension: Increasing the Density of OSN

- So far each late mover observes at most $k = 1$ early consumers
- Consider large $k$
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Consider large $k$

Organic social information
- Observed independently with probability $v_B$ by each late mover
- $k$ independent draws from early consumer population
- Purchase of product 1 drawn with probability $\phi_1$
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- $k$ independent draws from early consumer population
- Purchase of product 1 drawn with probability

$$\frac{\phi_1 m_1^s}{\phi_1 m_1^s + \phi_2 m_2^s}$$
Theorem

As $k$ grows large social advertising expenditures converge to zero in any equilibrium and for any viralities $(v_B, v_S)$. The total advertising revenue in the maximal revenue equilibrium is smaller for large $k$ than for $k = 1$. 
Conclusion

- We model an online social network that
  - controls social information flows
  - aims at maximizing advertising revenue
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  - controls social information flows
  - aims at maximizing advertising revenue
- We find that in equilibrium
  - organic virality is shut down
  - social information flows are unbiased
  - but social information might be limited