Word of Mass: The Relationship between Mass Media and Word-of-Mouth

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Literature review

- **Theoretical:**
  - Candogan et al. (2010) assumes knowledge of complete structure of the network and decide how much each consumer should pay for the product.
  - Campbell (2013) studies the optimal pricing in the presence of word-of-mouth communication.

- **Empirical:**
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**Empirical:**

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- To induce sales the monopolist advertises the product to the population.

Advertising is costly and producer pays $c_1 - s$ for advertising the product to proportion $s$ of consumers. The cost function is convex in $s$, representing the idea that it is impossible to control who gets an advertisement. The innovator knows degree distribution of the network $p(k)$ and chooses optimally price $p$ and amount of advertising $s$. 

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- The innovator knows degree distribution of the network $p(k)$ and chooses optimally price $P$ and amount of advertising $s$. 
Model cont’d

Consumers:

There is a continuum of consumers that are embedded into a network, given by classical random graph with connectivity $\lambda$. All consumers have an outside option $\gamma_i$ which is distributed as $U[0,1]$. A consumer buys the product if $v - P > \gamma_i$ thus the probability that a consumer buys the product is $q = v - P$. Consumers can buy the product only if they learn about it from:

▶ Direct advertisement from the producer.
▶ Observing a neighbor who has acquired the product.

No information asymmetry - once consumer knows about the product she knows immediately its quality.
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Demand function:

\[ D(s, v, P) = s(v - P) + (1 - s)(v - P) \sum_{k=0}^{\infty} p(k)(1 - (1 - w)^k) \]

\[ = (v - P) \left( 1 - (1 - s)e^{-\lambda w} \right) \]

where \( w \) is the probability that a randomly chosen consumer buys the product and \( p(k) = \frac{\lambda^k e^{-\lambda}}{k!} \).
Demand function:

\[ w = s(v - P) + (1 - s)(v - P) \sum_{k=1}^{\infty} \xi(k)(1 - (1 - w)^{k-1}) \]

\[ = (v - P) (1 - (1 - s)e^{-\lambda w}) \]

where \( \xi(k) = \frac{kp(k)}{\sum_{j=1}^{\infty}jp(j)} = \frac{kp(k)}{z_1} \) is the degree distribution of a neighbor.
Monopolist problem

\[
\max_{s,P} \quad wP - \frac{c}{1-s}
\]

\[s.t. \quad w = (v - P) (1 - (1 - s)e^{-\lambda w})\]

\[\text{Solution:}\]

\[
s^* = 1 - \frac{2\sqrt{ce^{\frac{w^*}{2}}} - \lambda c}{v}; \quad P^* = \frac{v}{2} \left( 1 - \frac{\lambda \sqrt{c}}{2e^{\frac{w^*}{2}} - \lambda \sqrt{c}} \right),
\]

where \[w^* = \frac{v}{2} - \frac{\sqrt{c}}{2} \left( \frac{2}{e^{\frac{w^*}{2}}} - \frac{\lambda v}{2e^{\frac{w^*}{2}} - \lambda \sqrt{c}} \right)\]
The effect of advertising cost.
Proposition

*The optimal price* $P^*$ *and amount of advertising* $s^*$ *decrease in the cost of advertising* $c$. *The same is true about awareness of the product and diffusion perimeter.*
The effect of cost on price and advertising

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- The monopolist substitutes more expensive advertising with word-of-mouth by lowering the price.
- However, word-of-mouth substitutes advertising only partially and the overall awareness of the product falls.
In general, sales of the product is non-monotone function in advertising cost $c$. More precisely, if $1 < \lambda v < 4$ then sales of the product first decrease, but after some level increase in $c$. If $\lambda v < 1$ sales are decreasing in $c$ on the whole range, while if $\lambda v > 4$ sales always increase in $c$. 
The effect of cost on sales

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- When advertising cost is small a price decrease makes existing advertising more efficient, but doesn't add much to product awareness.
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- When advertising cost is small a price decrease makes existing advertising more efficient, but doesn't add much to product awareness.
- When cost is high, a price decrease increases both advertising efficiency and awareness.
The effect of cost on sales

- Can sales be higher in the case of incomplete information?
The effect of cost on sales

- Can sales be higher in the case of incomplete information?

![Graph showing w* vs c]

**Proposition**

For sufficiently high cost $c$ and $\lambda v > 2$ the sales in the case of incomplete information are higher than in the case of complete information. The statement is also true for sufficiently high connectivity $\lambda$. 
The effect of advertising cost $c$ ($\lambda = 1.85, \nu = 0.7$)

Induced network of buyers: $c = 0, s^* = 1, P^* = 0.35$
The effect of advertising cost $c$ ($\lambda = 1.85, \nu = 0.7$)

Induced network of buyers $c = 0.1, s^* = 0.28, P^* = 0.22$
The effect of advertising cost $c$ ($\lambda = 1.85$, $\nu = 0.7$)

Induced network of buyers $c = 0.2$, $s^* = 0.16$, $P^* = 0.13$
The effect of advertising cost $c$ ($\lambda = 1.85$, $\nu = 0.7$)

Induced network of buyers $c = 0.3$, $s^* = 0.11$, $P^* = 0.03$
Consumer Surplus

Proposition

If $\lambda v > 1$ the consumer surplus is non-monotone functions in advertising cost $c$. More precisely, first consumer surplus falls, but after some level consumers become better-off as the cost increases. When $\lambda v < 1$ consumer surplus decreases in the cost on the whole range.
Proposition

If $\lambda v > 1$ the consumer surplus is non-monotone functions in advertising cost $c$. More precisely, first consumer surplus falls, but after some level consumers become better-off as the cost increases. When $\lambda v < 1$ consumer surplus decreases in the cost on the whole range.

- An increase in the advertising cost decreases product awareness, but price decrease is more than sufficient to offset this change.
Social Welfare

- What about social welfare? Can it grow in $c$?
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**Proposition**

*If $2 < \lambda v < 6$ then social welfare first decreases in $c$ up to the point where $c = \frac{1-\lambda v+\sqrt{1+4\lambda v}}{\lambda^2}$ and then increases. If $\lambda v < 2$ then social welfare always decreases while for $\lambda v > 6$ social welfare always increases in $c$.***
The effect of connectivity.
The effect of $\lambda$ on advertising level

Proposition

The amount of advertising is a non-monotone function in connectivity $\lambda$. More precisely, for sufficiently small $\lambda$ it increases in $\lambda$, while for sufficiently high $\lambda$ decreases. If the advertising cost is sufficiently low then the advertising level always decreases in $\lambda$.

Proposition

The optimal price decreases in connectivity $\lambda$. 
Proposition

If network connectivity $\lambda$ is sufficiently small then both consumer surplus and sales increase in $\lambda$. When network connectivity is sufficiently high and advertising cost is sufficiently low both consumer surplus and sales decrease in $\lambda$. 