Crowdsourcing the Last Mile

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Views expressed are of authors alone.
Agenda

• The Issue
• A Few Points on Two-Sided Markets
• Crowdsourcing Goods Delivery
• Uberization of Goods Delivery?
• Modeling Delivery Crowdsourcing
• Some Comparative Statics
• Conclusions
The Issue

• National Hub & Spoke companies dominate delivery.
  • Thrive on Density
  • Long-haul transportation (hard to beat in that market)
  • Can they satisfy the growing demand for service quality?
    • Same Day, 2 hr, 1 hr?
    • Local markets, local fulfillment?

• Ridesharing Platforms
  • Two-sided: drivers and riders
  • Moving into same day package delivery
  • Attract enough volume build network?
  • Pricing flexibility
  • Low fixed cost
The Battle

• UPS can put a driver on every block every day, Uber can put a driver on every block every minute – Ryan Peterson

• . . . delivery systems are more likely to succeed with top-down optimization, no matter how badly a sharing economy corporation tries to screw its non-employee employees – Michael Byrne
A Few Points on Two-Sided Markets

Classic works:
Armstrong (2006)
Rochet and Tirole (2003)
Eisenmann (2005).

Demand on one ‘side’ of a market is highly sensitive to action on the other.

Uber can attract drivers only if there are enough riders
Merchants will accept a credit card only if enough people want to use it to pay.
Two-Sided Markets

Pricing Implications: profit max mark-up depends not just on own elasticity but on the reaction on the other side.

EG: Charge shoppers to visit a mall, decline in shoppers, decline in stores (cross-side network effect), reduces value to shoppers, demand falls.

Cross-side effects supercharge some impacts.

Two reasons why prices differ from ordinary markets

Profit max prices differ because of external effects in equilibrium
Profit may be sacrificed for growth purposes, leading to subsidies, penetration pricing, etc.
Related: ‘chicken-and-egg’ problem

No side will join while the other side is missing.

2-Sided Platform - Strong entry barriers after growth – but how do you get there? And who gets there first?

Causes some platforms to subsidize a side or to use penetration pricing, delaying profits until after the network has grown.
Two-Sided Markets

Platform Design: How many sides and how open should they be?

NHS delivery company: Driver side closed
Uber: Driver side (mostly) open
   Bilateral rating system – partial side closure

Kontio (2016) - survey of crowdsourcing goods delivery companies
   Highly varied approach to both pricing and design.
   Either side could be the money side (change over life-cycle)
   Open sides often subsequently closed to improve quality
   Firm hires its own drivers
Ride Sharing and Goods Delivery

Special characteristics of this integration

Network does not have to be built from scratch

Integration depends on scope economies among ride sharing and goods delivery

Alternative to Uberization – expansion of Amazon into crowdsourced parcel delivery

Essential requirement: beat NHS company on quality in specific local markets
A Model of Entry by a 2-Sided Platform

Market: local, same-day delivery of packages from retail stores to consumers

Prior to entry, delivery provided by a monopoly NHS company.
   Network built to serve multi-day market
   Not easy to provide the service quality of same-day
   NHS quality is low relative to wtp for rapid delivery.

After entry, the platform provides delivery for a fee.
   \( \rho \) = the delivery charge to consumer
   \( \delta \) = the driver’s pay
Explicit External Cross Effect

Perceived quality, $q$, is a function of delivery time

Delivery time falls as $n_d$, the number of drivers rises, so we specify $q$ as a positive but decreasing function of the number of drivers.

$$q = n_d^\alpha, \ 0 < \alpha < 1.$$ (The impact of an added driver falls as $n_d$ declines.)
Consumers differ in their willingness-to-pay for rapid delivery

Heterogeneous
Uniformly distributed
Indexed by $0 < \theta < 1$

$$U(\theta) = N(\theta(q - \overline{q}) - \rho),$$

Where $N$ is the expected orders per consumer and $\overline{q}$ is the quality provided by the NSA delivery company (utility associated with $\overline{q}$ is denoted $\theta$).

Consumer joins if $U(\theta) > 0$, i.e., if their added utility outweighs the delivery charge.
Drivers

Earn net income of $\delta - c_d$

Heterogenous in the disutility they experience

Uniformly distributed and indexed by $0 < \gamma < 1$

\[ V(\lambda) = N(\delta - c_d - \lambda) \left( \frac{n_c}{n_d} \right), \]

where $N$ is the expected orders per consumer

and $N \frac{n_c}{n_d}$ is expected packages per driver.

Drivers will join if $V(\lambda) > 0$, because net income outweighs disutility and cost.
Critical Values

\[ 0 \leq \theta^* \leq 1 \]

A consumer joins iff \( \theta > \theta^* \), so that

\[ n_c = 1 - \theta^* , \text{ where } \theta^* = \theta^* \left( q(n_d) q, \rho \right) \]

\[ 0 \leq \gamma^* \leq 1 \]

Driver joins iff \( \lambda < \lambda^* \), so that

\[ n_d = \lambda^* , \text{ where } \lambda^* = \lambda^*(\delta, c_d, N, n_c) \]
The Platform

The platform’s profit is

\[ \Pi_{\rho,\delta} = N n_c (\rho - \delta) \]

Optimizing finds profit maximizing \( \rho \) and \( \delta \).

In lieu of an analytical solution, we examine the model numerically by assigning values and performing three comparative statics exercises.
Baseline Solution

Initial settings

\[
\alpha = 0.25 \\
c_d = 0.10 \\
\theta = 0.05
\]

A low value for the service quality of the NHS company needed to support an interior solution \((n_c > 0, n_d > 0)\).

With high utility from NHS, positive driver fees and delivery charges that yield positive profits will not exist.
# Numerical Analysis

<table>
<thead>
<tr>
<th>Baseline Solution</th>
<th>Value</th>
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<tbody>
<tr>
<td>( \rho )</td>
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<td>( \theta^* )</td>
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<tr>
<td>( N_c ) over ( N_d )</td>
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Raise Driver Cost

Increase $c_d$ by 50% (0.10 to 0.15)
Leads to large increase in $\delta$ to increase $n_d$.
The delivery charge, $\rho$, also increases to preserve profit.
Limits to increase in $\rho$, else $n_c$ falls too far.
Already some fall in $n_c$. Increase in value of network to consumers swamped by increase in $\rho$.
Platform may be willing to sacrifice profit for growth might dampen further the increase in $\rho$.
Recall: two reasons for price behavior: external effects in equilibrium and concern to grow the network early on.
Raise Driver Cost

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<tr>
<td>Nc over Nd</td>
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Increase NHS Quality

Increase $\theta$ by 50%
Platform faces more competition.
Lowers $\rho$ to keep consumers
Small increase $\delta$ to increase consumer utility at a given $\rho$
Both $n_c$ and profit fall.
**Increase NHS Quality**

<table>
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Strengthen External Cross-side Effect

Increase $\alpha$ by 50%

$\alpha$ is the rate at which increases in drivers increase quality

As the value of the network increases, $\delta$ rises to bring on more drivers.

The delivery charge falls very slightly, but not enough to keep profits up.
Strengthen External Cross-side Effect

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<td>$N_c$ over $N_d$</td>
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Same-Side Cost Complementarity

Scope economies among driver activities
    Formal – Uberization model or
    Informal – Amazon Flex

Impact primarily on $\lambda^*$ and $c_d$
    Little added disutility (or cost) if driver is already nearby.

Shift in $\lambda^*$, directly or thru the impact on $c_d$ increases the number of drivers below the critical disutility value and $n_d$ will rise.

Facilitates entry by the platform.

Beware, however, diseconomies have the opposite effect. Coordination failure could doom project.
Conclusions and Future Work

Model explores the conditions under which a ride-sharing platform could enter parcel delivery industry

- Essential to compete on service quality
- Strong cross-side effects
- Same-side cost complementarity

Future work would focus on integrating the specific characteristics of the same-side partners into the model

And likely effects over time: growth v profits, platform design

And of course await empirical data that would come from further market experiments.
And so,