Network Externalities and the Digital Divide[1]

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[1] The views expressed in this paper are solely those of the authors and should not be construed to represent the views of George Washington University, Howard University, the USPS Office of the Inspector General, or any other institution.

USO Research

- Quantification
  - Cohen, et al (2000)
  - Crew and Kleindorfer (2001,2004)
- Finance
  - Panzar (2000)
  - Cremer (2000)
- Convergence
  - Perkins (2001)
  - Jaag and Trinkner (2011)
- Welfare Foundations
  - Boldron, *et al* (2009)
  - Cremer, *et al* (2008)

USO Foundations

- Equity
- Social Cohesion
- Efficiency
  - Two-sided market theory
  - Network External Effects

Two-sided Markets

- Senders (firms)
- Recipients
  - addresses
  - households
- Postal Operator – platform
- External effects
  - senders
  - recipients

Market solution underserves

Extend the Analysis

- Framework
- Analyze postal network valuation

Questions

- How does the value of the network change as ICT alternatives allow people to drop off of it?
- Intrinsic value of the mail?
- Market vs. optimal outcomes?
- Is there a role for delivery charges as mix of mail changes?

Some Notation

- Two types of recipient
  - high-value
  - low-value
- ρ - proportion of high-value recipients out of N total addresses
- ρN high-value recipients
- $(1 - \rho)N$ low-value recipients
- $\mu_i(p_A)$– proportion of recipients of value $i = \{h,l\}$ who participate in mail market
- x_i - volume

Sender Surplus

$$S^S = \rho\mu_h(P_A)N\left[\alpha x_h - \frac{\alpha}{2}x_h^2\right]\lambda(\rho) + (1-\rho)\mu_l(P_A)N\left[\alpha x_l - \frac{\alpha}{2}x_l^2\right] + Z^S$$

Z^S – composite commodity

$\lambda(\rho)$ – sender externality

Utility of high- and low-value recipients

$$\Gamma^h = dx_h + \frac{\delta}{2}x_h^2$$

and

$$\Gamma^l = gx_l - \frac{\gamma}{2}x_l^2$$

Recipient Surplus

$$S^R = \rho\mu_h(P_A)N\left[dx_h + \frac{\delta}{2}x_h^2\right] + (1-\rho)\mu_l(P_A)N\left[gx_l - \frac{\gamma}{2}x_l^2\right] + Z^{Rh} + Z^{Rl}$$

- Z^{Ri} – composite commodity
- δ – high-value recipient externality
- γ – low-value recipient externality

Cost, Profit and Welfare

- Operator cost – Fixed and constant variable

- Profit - Revenue – cost

- Welfare = recipient surplus + sender surplus + profit

Social Planner Solution

$$x_h = \frac{\lambda(\rho)a + d - c}{\lambda(\rho)a - \delta}$$

and

$$x_l = \frac{a + g - c}{a + \gamma}$$

Market Solution

$$X_h = X_l = X$$

$$pX_h = pX_l = pX$$

Volume, profits and welfare differ from the social planner solution

Calibrating the Model

Specify the sender externality, $\lambda(\rho)$

$$\lambda = 1 + \frac{2\rho}{10}$$

Values for utility and cost functions:

Sender		HV Recipient		LV Recipient		Operator	
A	0.3	d	0.005	G	0.0025	c	0.2
A	0.01	δ	0.00006	Γ	0.000002	F	100
R^S	100	R^{RH}	20	R^{RL}	20	N	1,000

Market versus Social Planner Solution

	Market Solution	Social Planner
ρ	0.95	0.95
P_A	0	0
Solutions		
Unit Price	0.25	
Unit Price (High Value)		0.159
Unit Price (Low Value)		0.195
Average Vol. Per Household	5	16.3
High-Value Vol. Per Household	5	16.6
Low-Value Vol. Per Household	5	10.5
Sender Surplus	225.0	1,691.3
High- Value Surplus	59.0	156.9
Low-Value Surplus	21.2	22.6
Profit	150	-749.3
Total Volume	5,000	16,325.4
Total Volume (High-Value)	4,750	15,801.4
Total Volume (Low-Value)	250	524.0
Social Welfare	455.2	1,121.4

Breakeven Solutions

Extreme solutions

- Profit Max
- Large subsidy

Breakeven constraints

- Social plan surplus greater
- No overall subsidy
- High-value recipients subsidize low-value

Electronic Alternative Increase

- $\rho = 65\%$
- Social Plan solution
  - x falls, x/recipient falls
  - Welfare falls

Delivery Charges?

$P_A > 0$

$$gx_l - \frac{\gamma}{2}x_l^2 \leq P_A < dx_h - \frac{\delta}{2}x_h^2 \quad \rightarrow \quad \mu_h = 1, \quad \mu_l = 0$$

- Market solution at $\rho = 65\%$
- Volume falls, but
- Volume/recipient rises
- Sender Surplus rises
- Welfare rises

Conclusions

- Market failure – USO
- Value of network under eSubstitution
- Delivery charges – sender surplus
- Further research