Vertical control of a distribution network – An empirical analysis of magazines

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Vertical restraints and distribution networks

- IO theory: upstream firm can achieve optimal network size N and optimal retail price p through suitable vertical restraints:
  - Following pairs of price instruments implement first-best:

$$(p, w) \text{ or } (p, A) \text{ or } (w, A),$$

    $\rightarrow$ pick two instruments from RPM, wholesale price or fixed fee
  - Direct control of the network size N is not necessary,
    $\rightarrow$ i.e. no need for restricted licensing
- This paper
  - Consider the role of restricted licensing when price instruments are incomplete
  - Provide empirical application to magazine distribution

Restricted licencing and policy in magazine distribution

- According to U.K. investigation on newpaper and magazine distribution there are two reasons for refusal to sell
  - Maintain quality standards
  - Prevent encroachment (cannibalization)
- Problems with "encroachment theory" of restricted licencing
  - Optimal encroachment can in principle be achieved through price instruments.
  - Not easy to distinguish between quality and encroachment reason for restricting entry.

This paper

- Cross-section of local markets i with the following specific features
  - Uniform retail price p (RPM)
  - Fixed fee insufficient to cover upstream firm's fixed costs
  - Uniform wholesale price w
- Develop and estimate an empirical model of restricted entry licensing
  - Model trade-off between market expansion and fixed costs from additional entry licences
  - Account for incomplete price instruments for upstream firm
- Research questions
  - What are the profit losses from incomplete price instruments (uniform versus market-specific wholesale prices)?
  - What are the profit effects from a ban on restricted entry licensing?

Outline

- Empirical framework for vertical control of a distribution network
  - Theoretical framework
  - Empirical implementation

  The model enables to estimate the extent of market expansion and uncover fixed costs.
- Application to retail magazine distribution
  - Data set and reduced form regressions
  - Uniform wholesale prices: results and counterfactuals
  - Market-specific wholesale prices: results and counterfactuals

Previous literature

- Vertical restraints to control number of firms
  - Gallini and Winter (1983), Perry and Groff (1985)
- Market-level models of entry
  - Free entry: Bresnahan and Reiss (1991), Berry and Waldfogel (1999)
  - Coordinated entry: Ferrari, Verboven and Degryse (2009)
  - Combination of free and coordinated entry: this paper.

Theoretical framework: payoffs

- Upstream firm's profits in market i:

$$\Pi_i^U(N_i, w_i) = (w_i - c^U)Q_i(N_i) - \delta F_i N_i$$

- Downstream retailer's profits in market i:

$$\pi_i^D(N_i, w_i) = (p - w_i - c^D)\frac{Q_i(N_i)}{N_i} - (1-\delta)F_i$$

- Total profits:

$$\Pi_i(N_i) = (p - c^U - c^D)Q_i(N_i) - F_i N_i$$

Outlet elasticity (between zero and one) is

$$\varepsilon_i(N_i) = \frac{\partial Q_i(N_i)}{\partial N_i}\frac{N_i}{Q_i(N_i)}$$

Theoretical framework: two potential models

- The upstream firm's maximization problem is

$$\max_{w_i, N_i} \Pi_i^U(N_i, w_i) \quad \text{subject to} \quad \pi_i^D(N_i, w_i) \geq 0.$$

- Two potential models
  - Market-specific wholesale price w_i $\longrightarrow$ coordinated entry, first-best
  - Uniform wholesale price w $\longrightarrow$ free or restricted entry, second-best
- For both models
  - Estimate market expansion effects and uncover fixed costs
  - Perform policy counterfactuals

Theoretical framework: market-specific wholesale prices

- Maximization problem simplifies to choosing N_i to maximize total profits $\Pi_i(N_i)$. This gives "coordinated entry" solution:

$$(p - c^U - c^D) Q_i'(N_i) = F_i$$

or

$$(p - c^U - c^D) \varepsilon_i(N_i) \frac{Q_i(N_i)}{N_i} = F_i.$$

- Upstream firm extracts all profits by setting w_i such that

$$(p - w_i - c^D) \frac{Q_i(N_i)}{N_i} = (1 - \delta) F_i,$$

or

$$\frac{p - w_i - c^D}{p - c^U - c^D} = (1 - \delta) \varepsilon_i(N_i).$$

Theoretical framework: uniform wholesale prices

- Given w, the upstream firm's maximization problem becomes

$$\max_{N_i} \Pi_i^U(N_i, w) \quad \text{subject to} \quad \pi_i^D(N_i, w) \geq 0.$$

- Two possible solutions
  - Non-binding profit constraint $\rightarrow$ markets with restricted entry

$$\frac{\partial \Pi_i^U(N_i, w)}{\partial N_i} = 0 \quad \text{and} \quad \pi_i^D(N_i, w) > 0$$

  - Binding profit constraint $\rightarrow$ markets with free entry

$$\frac{\partial \Pi_i^U(N_i, w)}{\partial N_i} > 0 \quad \text{and} \quad \pi_i^D(N_i, w) = 0$$

Theoretical framework: uniform wholesale prices (2)

- This can be written as

$$\min\left\{\frac{\partial \Pi_i^U(N_i,w)}{\partial N_i}, \pi_i^D(N_i,w)\right\} = 0.$$

or

$$\min\left\{\frac{w-c^U}{\delta}\varepsilon_i(N_i), \frac{p-w-c^D}{1-\delta}\right\}\frac{Q_i(N_i)}{N_i} = F_i.$$

- Restricted entry in markets where market expansion is sufficiently low

$$\varepsilon_i(N_i) < \frac{p-w-c^D}{w-c^U-c^D}\frac{\delta}{1-\delta}.$$

- Free entry otherwise.

Empirical implementation: two potential models

- Optimality condition for N_i:
  - Coordinated entry (market-specific wholesale price)

$$(p - c^U - c^D)\varepsilon_i(N_i)\frac{Q_i(N_i)}{N_i} = F_i.$$

  - Restricted/free entry (uniform wholesale price)

$$\min\left\{\frac{w - c^U}{\delta}\varepsilon_i(N_i), \frac{p - w - c^D}{1 - \delta}\right\}\frac{Q_i(N_i)}{N_i} = F_i.$$

- Rewrite to take to the data:
  - We observe revenues rather than quantities
  - N_i is integer rather than continuous (entry inequalities)

Empirical implementation: rewriting entry conditions

- Revenue equation

$$R_i = R_i(N_i) = pQ_i(N_i)$$

- Entry equation
  - Coordinated entry (market-specific wholesale price)

$$\mu \varepsilon_i(N_i) \frac{R_i(N_i)}{N_i} = F_i,$$

with $\mu = (p - c^U - c^D)/p$.

  - Restricted/free entry (uniform wholesale price)

$$\mu \min \left\{ \frac{1}{\delta} \frac{w - c^U}{p - c^U - c^D} \varepsilon_i(N_i), \frac{1}{1-\delta} \frac{p - w - c^D}{p - c^U - c^D} \right\} \frac{R_i(N_i)}{N_i} = F_i.$$

Empirical implementation: revenue equation

$$R_i = R_i(N_i) = A_i N_i^{\alpha_i} S_i$$

with

$$\ln A_i = X_i \beta + \eta_{i1}.$$

This gives

$$\ln R_i/S_i = X_i \beta + \alpha_i \ln N_i + \eta_{i1}$$

Market expansion effect is market-specific

$$\alpha_i = \alpha_0 + \alpha_1 \text{surface} + \alpha_2 \ln N_i$$

Empirical implementation: entry inequalities

- Under coordinated entry, the observed number of entrants N_i satisfies

$$\mu \left(R_i(N_i + 1) - R_i(N_i) \right) < F_i \leq \mu \left(R_i(N_i) - R_i(N_i - 1) \right)$$

- with

$$\ln F_i = W_i \gamma + \eta_{i2}.$$

- Analogous entry inequalities under restricted/free entry.

Empirical implementation: econometric model

- Under coordinated entry, the simultaneous model is

$$\ln R_i/S_i = X_i\beta + \alpha_i \ln N_i + \eta_{i1}$$

$$Z_i\theta + \tau_i(N_i + 1) < \eta_{i2} - \eta_{i1} \leq Z_i\theta + \tau_i(N_i)$$

  where η_{i1} and η_{i2} have joint normal distribution and

$$\begin{aligned} Z_i\theta &\equiv \ln\mu + X_i\beta + \ln S_i - W_i\gamma \\ \tau_i(N_i) &\equiv \ln(N_i^{\alpha_i} - (N_i - 1)^{\alpha_i}) \end{aligned}$$

  This is simultaneous revenue and ordered probit model. Exclusion restriction on S_i for endogeneity of N_i.

- Analogous expression for $\tau_i(N_i)$ under restricted/free entry.

Magazine distribution

- (Uniform) RPM
- Uniform wholesale prices across markets ($w/p = 0.75$)
  - How large is the profit inefficiency of uniform wholesale prices?
- Restricted licensing
  - What would be the profit effect of a ban on restricted licensing?
- Identifying assumptions: $c/p = 0$, $c^D/p = 0.2$

Data set

	all markets		$N_i > 0$	
press shop revenues (R_i/S_i)	5.19	2.76	5.58	2.45
subscriptions revenues	1.48	0.55	1.49	0.54
press shops (N_i)	2.12	2.73	3.19	2.80
supermarkets	0.50	0.90	0.72	1.02
grocery stores	0.38	0.77	0.47	0.87
petrol stations	0.17	0.52	0.24	0.61
surface	29.83	28.22	36.91	29.44
foreign	0.04	0.06	0.05	0.06
young	0.22	0.03	0.22	0.02
elderly	0.16	0.03	0.16	0.02
income	2.48	0.39	2.52	0.37
unemployment rate	0.03	0.02	0.03	0.02
Flanders	0.45	0.50	0.53	0.50
number of observations	950		631	

Reduced form regressions

	press shops		subscriptions	
press shops	0.46	(0.03)	−0.02	(0.01)
supermarkets	−0.11	(0.02)	−0.00	(0.02)
grocery stores	−0.09	(0.02)	0.00	(0.02)
petrol stations	−0.05	(0.03)	0.01	(0.03)
constant	1.96	(0.50)	−1.74	(0.30)
surface	−0.16	(0.03)	0.07	(0.02)
foreign	−2.35	(0.34)	−2.35	(0.24)
young	−1.67	(1.35)	1.43	(0.73)
elderly	−0.92	(1.00)	1.27	(0.62)
income	−0.13	(0.16)	0.84	(0.11)
unemployment rate	5.06	(1.83)	6.62	(1.21)
Flanders	0.65	(0.06)	0.81	(0.04)
R^2	0.51		0.52	
number of observations	631		949	

Restricted/free entry model: results

	revenue		entry	
α_0	0.23	(0.05)		
α_1	0.04	(0.01)		
α_2	−0.04	(0.01)		
supermarkets	−0.02	(0.02)		
grocery stores	−0.11	(0.02)		
petrol stations	−0.00	(0.03)		
constant	1.65	(0.55)	7.51	(0.58)
surface	−0.13	(0.03)	0.08	(0.04)
foreign	−2.10	(0.20)	−1.80	(0.25)
young	−2.35	(1.42)	−0.65	(1.49)
elderly	−0.39	(1.11)	−3.25	(1.19)
income	0.00	(0.17)	0.51	(0.18)
unemployment rate	8.11	(1.78)	5.67	(1.71)
Flanders	0.71	(0.07)	0.82	(0.07)
$1-\delta$			0.11	(0.01)

Restricted/free entry model: summary

- Outlet elasticity
  - is 0.31 in representative market
  - is higher in markets with large surface and few outlets, varying between 0.18 and 0.46
- Other types of distribution outlets have relatively small effect on revenues
- Control variables: surface, foreign, unemployment
- Per outlet fixed cost F_i is €3,041 in representative market, of which 11% is borne by the retailer

Restricted/free entry model: counterfactuals

	first best	uniform fee licensing	uniform fee ban
w/p	76.32	75.98	76.85
	(0.04)	(0.22)	(0.10)
2.5% w/p	71.77		
	(0.15)		
97.5% w/p	77.96		
	(0.03)		
N	2034	1947	2169
	(39.35)	(44.98)	(119.41)
π^D	0.00	0.45	0.07
	(0.00)	(0.07)	(0.00)
Π^U	19.29	18.43	17.99
	(0.73)	(0.71)	(0.70)
Π	19.29	18.88	18.06
	(0.73)	(0.71)	(0.70)

Restricted/free entry model: summary of counterfactuals

- Profit inefficiency of uniform wholesale prices is about 5%
- Refusal to supply in about 35% of the markets
- Ban on restricted licensing slightly lowers profits (2%) and raises number of outlets

Coordinated entry model: results

	revenue		entry	
α_0	0.43	(0.03)		
α_1	0.06	(0.01)		
α_2	−0.08	(0.01)		
supermarkets	−0.04	(0.02)		
grocery stores	−0.11	(0.02)		
petrol stations	−0.01	(0.03)		
constant	1.80	(0.53)	8.48	(0.58)
surface	−0.23	(0.03)	−0.03	(0.04)
foreign	−2.36	(0.20)	−2.09	(0.29)
young	−0.89	(1.36)	1.08	(1.54)
elderly	−0.20	(1.09)	−3.06	(1.25)
income	−0.16	(0.17)	0.32	(0.19)
unemployment rate	4.86	(1.65)	2.00	(1.76)
Flanders	0.61	(0.06)	0.71	(0.07)

Coordinated entry model: summary

- Outlet elasticity
  - is 0.49 in representative market
  - is higher in markets with large surface and few outlets, varying between 0.20 and 0.73
- Other types of distribution outlets have relatively small effect on revenues
- Control variables: surface, foreign, unemployment
- Per outlet fixed cost F_i is €4,878 in representative market, of which 11% is borne by the retailer

Coordinated entry model: counterfactuals

	first	uniform fee	
	best	licensing	ban
w/p	75.19	74.81	0.78
	(0.04)	(0.21)	(0.01)
$2.5\% w/p$	71.45		
	(0.12)		
$97.5\% w/p$	77.40		
	(0.06)		
N	2001	1878	2049
	(39.14)	(45.45)	(97.03)
π^D	0.00	0.54	0.07
	(0.00)	(0.06)	(0.00)
Π^U	16.75	15.85	15.02
	(0.70)	(0.67)	(0.65)
Π	16.75	16.39	15.09
	(0.70)	(0.69)	(0.65)

Coordinated entry model: summary of counterfactuals

- Profit inefficiency of uniform wholesale prices is about 5%
- Refusal to supply in about 30% of the markets
- Ban on restricted licensing slightly lowers profits (5%) and raises number of outlets

Conclusions

- Upstream firm can control the size of its network with price instruments or through direct control
- Market expansion shows important variation across markets
- Profit inefficiency of uniform wholesale prices is relatively low –> Provides rationale for why uniform wholesale prices are observed to be uniform
- Ban on restricted entry (under uniform wholesale fees) raises retail outlets but does not impact profits very much –> If restricted licensing is prevalent, it is to obtain quality standards rather than prevent encroachment