Preemption in spatial competition: Evidence from the retail pharmacy market

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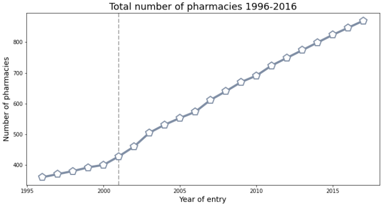
Background

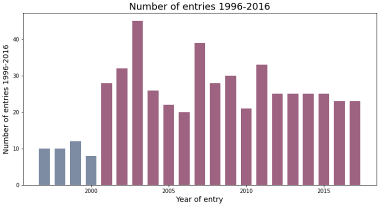
- Urbanization and urban-rural inequality put spatial policies on the forefront of the political debate
- Optimal policy design requires an understanding of location decisions by firms
- Economic theory points at multiple forces that can render firm location configurations inefficient in spatially differentiated markets (business-stealing incentives, local market power considerations, preemption motives)
- These issues can lead to unrealized gains for consumers and firms

Market deregulation and entry

- Liberalization of entry in the pharmacy market in Norway in 2001
- Rapid growth in the number of pharmacies after deregulation
- New policy led to horizontal integration and concentration of the market
- Previously independent pharmacies were consolidated into three nation-wide chains which now constitute 85% of the market

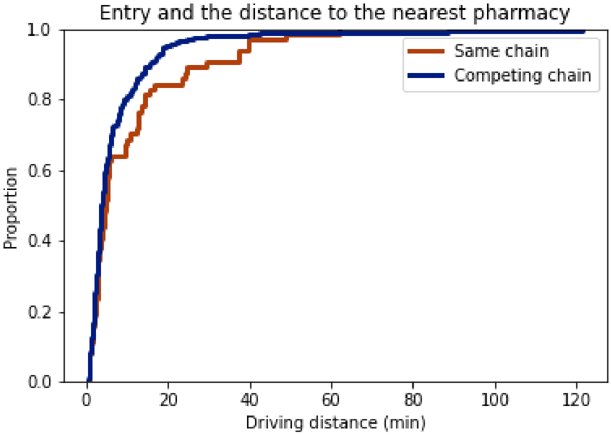
Development of pharmacies





Entry behaviour in spatial competition

- Hotelling model with endogenous location and fixed prices prediction: always locate closer to a competitor
- Multi-store firm: tradeoff between cannibalisation and business-stealing motives



Questions

- What are these entries when the closest player is a pharmacy of the same chain?
  - Preemptive behaviour (Igami and Yang 2013; Zheng 2016)
  - Market segmentation by store format differentiation (Ellickson, Grieco, and Khvastunov 2020)
  - Network effects (Holmes 2011; Ellickson, Houghton, and Timmins 2013)

Preemption in spatial competition

- There has been a large theoretical literature studying preemption in spatial competition, but the empirical work has lagged behind
- Preemptive incentives are important in multi-store retailers' entry decisions and can lead to a substantial loss of producer surplus (Zheng 2016)
- The definition of preemptive entry hinges on how much the likelihood of one firm entering a particular location today is impacted by the likelihood of its opponent entering the same location in the future (Zheng 2016)
- Igami and Yang (2016) showed the role of market shocks commonly observed by firms in preemptive entries
- We propose that private information held only by market incumbents may play role in preemptive behaviour as well

Institutional setting

- Focus on the market of prescription drugs (about 70% of turnover)
- Sale of pharmaceuticals in Norway is highly regulated and only permitted at licensed pharmacies
- Market regulation:
  - Reference price regulation
  - Price ceilings
  - Reimbursement through National Insurance Scheme
- Need to handle:
  - no scope for price competition,
  - multi-store oligopoly,
  - presence of dynamic strategic interactions.

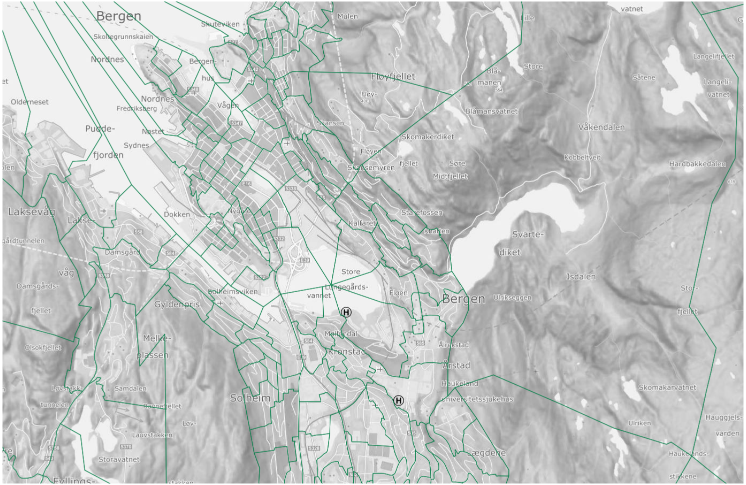
Data

- Individual level purchases of prescription drugs from 2004 to 2011,
- Geocoded data on pharmacy locations,
- Pharmacy characteristics: affiliation, size, standing alone or in a shopping mall,
- Pharmacies openings between 2004 and 2011,
- Gender and age population distribution by basic units (similar to census blocks in the US),
- Route information between basic units (areas where people live) and pharmacies.

Summary statistics

Transactions	
Observations (million transactions)	144.6
Total amount (NOK)	485
No. packages	1.25
Gender composition	
Male	0.436
Female	0.564
Age composition	
0-24	0.064
25-45	0.103
46-59	0.182
60-74	0.297
75-89	0.280
90+	0.074

Bergen division on basic units



Localized competition - market definition

- Overlapping markets: all pharmacies that individual can reach within one-hour drive

Demand Model Overview

Spatially disaggregated discrete-choice model:

$$R_{gjt}(\theta) = \sum_{l=1}^{L} Q_{glt}(\theta) Pr_{glt}(j|\theta),$$

where
l is location (BU), t is period, g is demographic group, and j is pharmacy,
R_{gjt} is revenue of pharmacy j in demographic group g at time t,
Q_{glt} is aggregate demand of group g in location l, function of groups and time,
$Pr_{glt}(j|\theta)$ is market share of pharmacy j in group g in location l, assumed to be logit, determined by distance, pharmacy characteristics, and market structure.

Consumer Random Utility

Consumer belonging to group g residing in location l going to pharmacy j in period t:

$$
\begin{aligned}
u_{igtj} &= v_{igtj} + \varepsilon_{igtj}, \varepsilon_{igtj} \sim \mathrm{IID\,EV\,I}, \\
v_{igtj} &= \gamma_g d_{igj} + \nu_g d_{igj} \times pop.density_{igt} + \kappa_g cost_{igj} + \delta_{gj} x_{jt}
\end{aligned}
$$

where
d_{igl} is distance between pharmacy j and location l,
$pop.density_{igt}$ is population density at location l at time t,
$cost_{igj}$ is cost of travelling between pharmacy j and location l,
x_{jt} is a vector of pharmacy characteristics at time t (mall location, nearby wine monopoly, etc.).

Full Demand Model

$$R_{gjt}(\theta) = \sum_{l=1}^{L} Q_{glt}(\theta) Pr_{glt}(j|\theta)$$

$$Q_{glt}(\theta) = (\beta_g + \tau_g t + \sum_{s=1}^{11} \mu_g^m \mathbf{1}\{month(t) = m\} + \xi_{g\ell t}) N_{glt}$$

$$Pr_{glt}(j|\theta) = \frac{\exp(v_{gltj}(\theta))}{\sum_{k \in \mathcal{J}_t} \exp(v_{gltk}(\theta))}$$

where
N_{glt} is number of individuals in group g living in location l at time t, $\xi_{g\ell t}$ is a location specific demand unobservable that determines the value of being present in the local market (play an important role later).

Econometric Approach

Minimum Distance Estimator:

$$\hat{\theta} = arg \min_{\theta} \sum_{j=1}^{J} \sum_{g=1}^{G} \sum_{t=1}^{T} [R_{gjt} - \hat{R}_{gjt}(\theta)]^2$$

Estimation Results (male)

	M0-24	M25-45	M46-59	M60-74	M75-89	M90+
Distance	-0.033***	-0.39***	0.300	-0.309***	-0.449***	-11.410
	(0.001)	(0.004)	(0.257)	(0.004)	(0.01)	(10.85)
Travel cost	0.002***	-0.057***	-1.588***	-0.024***	-0.065***	-35.73
	(0.000)	(0.002)	(0.544)	(0.001)	(0.004)	(34.04)
Distance x pop.density	0.000***	0.000***	-0.971***	-0.000***	-0.000***	-0.581
	(0.000)	(0.000)	(0.335)	(0.000)	(0.000)	(0.550)
Pharmacy size (m^2)	0.001***	0.001***	0.216***	0.001***	0.002***	1.317
	(0.000)	(0.000)	(0.074)	(0.000)	(0.000)	(1.246)
Center	-0.169***	-0.076***	0.006	-0.132***	-0.076***	-3.366
	(0.006)	(0.009)	(0.879)	(0.008)	(0.015)	(4.445)
Mall	-0.127***	-0.366***	0.059	-0.233***	-0.312***	2.712
	(0.010)	(0.013)	(2.497)	(0.010)	(0.017)	(8.180)
Large mall	0.282***	0.231***	-0.091	-0.080***	-0.362***	3.244
	(0.008)	(0.009)	(1.162)	(0.009)	(0.017)	(6.830)
Wine monopoly	0.114***	-0.217***	-0.078	0.084***	0.239***	-2.560
	(0.021)	(0.029)	(1.586)	(0.026)	(0.047)	(105.5)
Wine monopoly x large mall	0.400***	0.155***	-0.153	0.138***	-0.201***	-5.944
	(0.006)	(0.008)	(0.608)	(0.007)	(0.012)	(6.717)

Note: Standard errors are in parentheses. Significance levels are * - $p < 0.1$, ** - $p < 0.05$, *** - $p < 0.01$.
Number of pharmacies - 724. Number of pharmacy-month pairs - 55285.
Number of pharmacy-month-BUs - 31569626. Number of parameters per group - 29.

Estimation Results (female)

	F0-24	F25-45	F46-59	F60-74	F75-89	F90+
Distance	-0.352***	-0.287***	-0.280***	-0.311***	-0.722***	-1.208
	(0.003)	(0.003)	(0.002)	(0.004)	(0.011)	(2.266)
Travel cost	-0.025***	-0.018***	-0.015***	-0.018***	-0.004*	0.824
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(1.582)
Distance x pop.density	0.000***	0.000***	0.000***	-0.000***	0.000***	-0.341
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.634)
Pharmacy size m^2	0.001***	0.001***	0.001***	0.001***	0.003***	2.091
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(3.885)
Center	0.008	-0.077***	-0.072***	-0.080***	0.189***	-0.965
	(0.009)	(0.007)	(0.007)	(0.008)	(0.021)	(10.02)
Mall	-0.269***	-0.269***	-0.164***	-0.186***	-0.426***	0.140
	(0.013)	(0.011)	(0.009)	(0.010)	(0.022)	(19.65)
Large mall	0.563***	0.407***	0.220***	0.078***	-0.485***	0.018
	(0.009)	(0.007)	(0.008)	(0.009)	(0.023)	(8.932)
Wine monopoly	0.094***	-0.084***	0.193***	0.193***	0.442***	-0.077
	(0.027)	(0.023)	(0.021)	(0.025)	(0.064)	(19.35)
Wine monopoly x large mall	0.554***	0.319***	0.291***	0.253***	-0.473***	-1.046
	(0.007)	(0.006)	(0.006)	(0.007)	(0.017)	(9.024)

Note: Standard errors are in parentheses. Significance levels are * - $p < 0.1$, ** - $p < 0.05$, *** - $p < 0.01$.
Number of pharmacies - 724. Number of pharmacy-month pairs - 55285.
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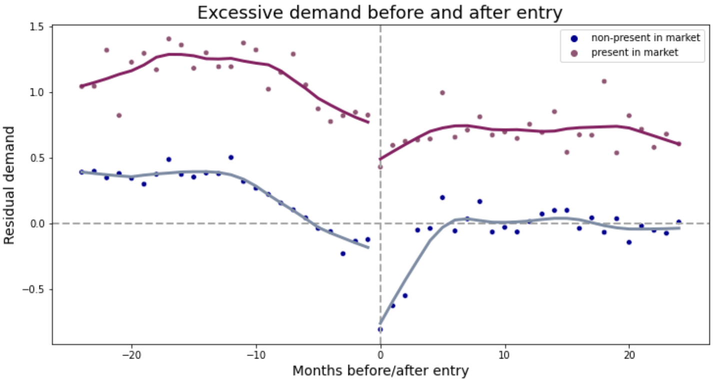
Role of private information

- Incumbents have an easier time learning about local market demand by observing their own sales in the market
- Incumbents can tell if the demand is higher than its characteristics would suggest - *residual demand*
- If such residual demand is *common information*, then all chains are equally likely to enter (Igami and Yang 2016)
- If shocks are *private information*, then the incumbent firm will be more likely to respond to positive demand residuals than competing firms
- Event study:
  - we classified entries based on whether the entering chain was incumbent,
  - computed average residual demand before and after entry.

Event study



Each dot is aggregated residual (excessive) local demand averaged over markets where entries occurred

Linear probability model

To control for differences in observable characteristics relating to the events, we use a linear regression specification:

$$1\{\text{same chain}\}_e = \alpha\hat{\xi}_e + x_e\beta + \text{error}_e,$$

where e denotes entry events, and $\hat{\xi}_e$ is the predicted demand residual averaged over the 3, 6, or 12 months prior to the entry, and where x_e is a vector of characteristics of the entry event, including chain dummies, characteristics of the store, and the market size.

Linear probability model: results

	Dep. Var.: Same/competing chain entry			
	I	II	III	IV
Center	0.12	0.11	0.12	0.15
	(0.14)	(0.13)	(0.13)	(0.15)
Small mall	0.33	0.41*	0.60**	0.72**
	(0.24)	(0.22)	(0.26)	(0.27)
Wine mon. in small mall	-0.25	-0.19	-0.20	-0.28
	(0.25)	(0.22)	(0.22)	(0.27)
Large mall	0.15	0.08	-0.03	0.06
	(0.15)	(0.14)	(0.14)	(0.15)
Wine mon. large mall	0.04	-0.00	-0.02	0.05
	(0.16)	(0.15)	(0.15)	(0.16)
Market size	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Residuals prior 3 months		0.13***		
		(0.03)		
Residuals prior 6 months			0.12***	
			(0.04)	
Residuals prior 12 months				0.13**
				(0.06)
Obs.	53	53	53	53

Firm Choice

- Model of dynamic entry competition in the spirit of Igami and Yang 2016
  - Simple extension of their model: attempt to capture the degree to which information is common or private
- We do not make any assumptions regarding the configuration of local markets (Ellickson, Grieco, and Khvastunov 2020)
  - Consumers are located across space according to register data at fine disaggregation

Sketch of Entry Model

- Three competitors - pharmacy chains
- State space is defined by a discrete set of locations $\mathcal{J}$ (the set of pharmacies present in the final year of our data)
- At each location at a point in time, there can be one of the three pharmacy chains or no pharmacy currently present: $s_{jt} \in \{0, 1, 2, 3\}$
- In each period each firm chooses a location j in space $\mathcal{J}$. The choice set for a firm is the set of locations where no other chain has yet opened a pharmacy

Sketch of Entry Model

- Flow profit from a pharmacy at location j:

$$\pi_{jt} = R_{jt} - VC_{jt}$$

  where R_{jt} is the total revenue earned at pharmacy j in period t, and VC_{jt} is total variable costs

- Revenue depends on the composition of sales

$$R_{jt} = \sum_{g} \sum_{l} Q_{glt}(\theta) Pr_{glt}(j|\theta),$$

  and Q_{glt} is aggregate demand of group g in location l, $Pr_{glt}(j|\theta)$ is market share of pharmacy j in group g in location l

Dynamic Problem

The dynamic problem takes the form:

$$\max_{d_1,\ldots,d_T} \sum_{t=1}^{T} \delta^t \mathbb{E}[\Pi_{ct}(S_t, d_t)],$$

where the chain-level profit is

$$\Pi_{ct}(S_t, d_t) = \sum_{j \in \mathcal{J}} \left[1\{s_{jt} = c\} \pi_{jt} \right] - FC(d_t) + \omega_{ct}(d_t),$$

where $FC(d)$ is the entry cost of opening a pharmacy in the chosen location, d, and ω_{ct} is a vector of independent and identically distributed private cost shocks

Information structure and timing

- When a firm has the right to move, it immediately observes current market configuration, demand shifters and idiosyncratic shocks to all currently available locations $\{\omega_{ct}(d)\}_{d \in \mathcal{D}(S_t)}$
- State of local demand $\xi_{\ell t}$ at a consumer location $\ell \in \mathcal{L}$ is a crucial variable for entry decision. We may decompose it into two parts:

$$\xi_{\ell t} = \rho \xi^1_{\ell t} + (1-\rho)\xi^2_{\ell t}, \quad \rho \in [0;1],$$

  where $\xi^1_{\ell t}$ is commonly observed by all firms and $\xi^2_{\ell t}$ is privately observed by the incumbent firm
- We define the incumbent chain c at location ℓ to be the firm that operates the pharmacy closest to ℓ
- The parameter ρ controls the extent to which market-level residual demand is common ($\rho \to 1$) or private ($\rho \to 0$) information

Challenges

- Identification of ρ
- Simultaneous entries in data
- Dimensionality: one big market, many possible configurations
- Process of information (common and private) dissemination in reality is much more complicated
- The problem of good and bad signalling

Market segmentation

- There is a surprisingly large amount of heterogeneity across consumer segments in terms of preferences for store characteristics
- If market segmentation was a primary driver, we would expect to see incumbents entering with significantly different characteristics

		Closest pharmacy to entrant	
	Total	Same chain	Competing chain
Distance to neighbor (driving min.)	8.0	10.5	7.2
Center	47.6%(107)	56.4%(31)	44.7%(76)
Shopping mall	32.0%(72)	29.1%(16)	32.9%(56)
Wine monopoly	7.6%(17)	3.6%(2)	8.8%(15)
Number of entries	225	55	170

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