Strategic Investment

Glenn Ellison

Empirical Approaches

Strategic investment theories identify incentives that firms may have to deter entry or reshape future competition.

In some cases, acting on these incentives may violate antitrust laws (for example, entry deterrence). In other cases, we are interested in the insights that empirical work may provide into (1) whether the incentives highlighted in models are important in practice; and (2) whether firms recognize and react to the incentives as rational models predict.

To better understand (1) we would like to describe $\frac{da_1^*}{dk_1}$ and $\frac{da_2^*}{dk_1}$ and the profit functions and entry costs.

We can think of (2) as asking which of several models best capture firm behavior. Sometimes it is useful to think of this in terms of different "rational" models

effects of investment on strategic variables

Empirical Approaches

t=1

Incumbent chooses k at cost c(k)

t=2

Entrant learns E ~ F(E). Chooses In/Out at cost E

t=3

Monopoly $\pi_1^{m*}(k)$
or
Duopoly $\pi_1^{d*}(k), \pi_2^{d*}(k)$

The nonstrategic "open loop" benchmark for k is the optimal choice in the model where firm 2 never observes k.

A benchmark in which the firm ignores the strategic entry deterrence motive, but reacts to accommodation incentives would be the optimal behavior in this model if firm 2 observed k at t=2½.

The standard strategic investment model is the optimal behavior in this model when firm 2 observes k at t=1½.

Empirical Approaches

Papers in the empirical strategic investment literature have taken several different approaches:

1. Examine effects of investment: $\frac{da_1^*}{dk_1}$ and $\frac{da_2^*}{dk_1}$.
2. Examine reduced-form predictions that differ between the nonstrategic and strategic models.
3. Estimate the strategic model structurally (and ideally test against competing models).

I'll discuss (or at least mention) papers using each approach.

Chevalier, "Capital Structure and Product Market Competition: Evidence from the Supermarket Industry," *AER* 1995

Chevalier, “Capital Structure and Product Market Competition”

Why firms choose the capital structures they do is a central question in the field of corporate finance. The Miller-Modigliani theorem noted conditions under which capital structure is irrelevant.

Among the many subsequent papers are ones noting that capital structure can be a strategic investment that affects product market competition.

The literature on the strategic impact of debt has identified potential effects on various actions that can go in both directions.

Chevalier, “Capital Structure and Product Market Competition”

Firms that take on a lot of debt need short-run cash flow to service the debt.

- In a standard static oligopoly game this has *no effect*: regardless of the need for cash, firms maximize profits.
- In dynamic models with customer loyalty, debt may lead firms to *raise prices* to (inefficiently) exploit the loyalty in the short run.
- In dynamic collusion models, we can get *lower prices* due to the Rotemberg-Saloner effect.

High debt raises the cost of capital and may make it more difficult to expand.

- In a standard Cournot model, this would lead *rivals to expand more*.
- In models in which firms are racing to enter a growing market, *rivals could slow expansion*.

Chevalier, “Capital Structure and Product Market Competition”

Chevalier treats a 1995-1998 wave of leveraged buyouts (LBOs) in the US supermarket industry as providing a natural experiment.

In 1984 the Haft family sold the Dart Drugstore chain for $160m. Soon after, they embarked on a series of attempts to buy a national supermarket chain via an LBO.

Their attempt to buy Safeway resulted in a stock market profit of $80m and an additional payment of $59m when Safeway management undertook a $5.3b LBO to avoid the takeover.

Similar takeover battles led to many other LBOs. Between 1995 and 1998 nineteen of the fifty largest US supermarket chains undertook LBOs.

The market-level impact of the LBO wave varied from city to city.

Chevalier, “Capital Structure and Product Market Competition”

The dataset includes:

- Annual information on the number of supermarkets in each chain in each of 85 MSAs from 1985-1991.
- Demographics of the MSAs (income, population) and changes from 1985 to 1991.
- Whether each 1985 store became part of an LBO firm by 1988 (and 1991).

It then examines:

- Effects of the *LBOShare* on the change in the total number of stores in the market.
- Effects on the expansion of existing non-LBO firms.
- Effects on entry by new firms.

Chevalier, "Capital Structure and Product Market Competition"

There is weak evidence that early LBOs led to an increase in the total number of stores, suggesting that LBOs soften price competition.

Variable	(1)	(2)	(3)
Constant	−0.0070	0.0075	−0.0006
	(0.1386)	(0.1380)	(0.1572)
Percentage change in households	0.6347**	0.5952**	0.5377**
	(0.1569)	(0.1581)	(0.1651)
Percentage change in income	−0.6731	−0.7661	−0.5778
	(1.1708)	(1.6374)	(1.1935)
Percentage change in income squared	0.1974	0.2282	0.1918
	(0.3558)	(0.3537)	(0.3630)
Change in share with income less than $10,000	−0.0071	−0.0076	−0.0044
	(0.0084)	(0.0084)	(0.0088)
Percentage change in households per square mile	58.7209	60.0863	52.8402
	(54.0745)	(53.6788)	(54.2677)
Percentage deviation from mean stores per household	−0.0866	−0.0831	−0.1194
	(0.0575)	(0.0571)	(0.0620)
Herfindahl index	−0.1079	−0.1171	−0.2920
	(0.2818)	(0.2798)	(0.3036)
Share LBO	0.0966	—	—
	(0.0775)		
Share early LBO	—	0.1736*	0.1438
		(0.0931)	(0.1369)
Share late LBO	—	−0.0175	0.0280
		(0.1094)	(0.1141)

Chevalier, "Capital Structure and Product Market Competition"

There is weaker evidence that non-LBO firms expanded more in markets in which a larger fraction of the existing stores underwent early LBOs.

TABLE 8—OLS ESTIMATION RESULTS FOR INCUMBENT FIRMS

	Coefficients	
Variables	(1) Non-LBO incumbents	(2) LBO incumbents
Change in households	−0.0660	−0.2690
	(0.1170)	(0.2350)
Change in income	0.2860	14.0750
	(6.2420)	(14.1650)
Change in income squared	0.0900	−1.3100
	(0.5750)	(1.2500)
Change in share with income less than $10,000	−0.4167	0.5441
	(0.4084)	(0.9351)
Change in households per square mile	−0.0033	0.0003
	(0.0039)	(0.0352)
Deviation from mean stores per household	0.0575*	0.0268
	(0.0250)	(0.0435)
Total stores	−0.0055*	−0.0005
	(0.0022)	(0.0042)
Market share	7.0556	−28.1176**
	(5.4637)	(10.2838)
Herfindahl index	29.6984	30.6566
	(11.9950)	(27.0131)
Share, early LBO	7.9665[a]	0.7648
	(4.1466)	(5.7235)
Share, late LBO	−1.0105	−5.8049
	(3.9945)	(9.0537)
Constant	−6.4550*	−3.2238
	(3.1960)	(6.7199)
R^2	0.12	0.14
Number of observations	184	113

Chevalier, "Capital Structure and Product Market Competition"

It is also more likely that there will be de novo entry into markets where the early LBO share is higher.

(De novo entry is defined as the entry of a chain with at least 25 stores elsewhere or by Kmart/Walmart.)

Overall the results are consistent with models in which LBOs make incumbents "soft". This could reflect that LBO firms raise prices (using up goodwill) or are capacity constrained, leading rivals to expand as in the Cournot model.

Variable	Coefficient
Change in households	0.0841*
	(0.0395)
Change in income	4.6880
	(2.9970)
Change in income squared	−0.4950[a]
	(0.2910)
Change in share with income less than $10,000	0.2859
	(0.1806)
Change in households per square mile	−0.0025
	(0.0032)
Deviation mean stores per household	0.0012
	(0.0064)
Herfindahl index	0.0887
	(2.9218)
Share, early LBO's	2.4183[a]
	(1.1330)
Share, late LBO's	0.6756
	(1.2177)
Constant	−1.518
	(1.0364)

Chevalier, "Do LBO Supermarkets Charge More: An Empirical Analysis of the Effects of LBOs on Supermarket Pricing," *JF* 1995

A separate paper (*Journal of Finance*, 1995) provides a complementary analysis of price levels and price changes. Among the findings are:

- By 1992, LBO firms typically charged 2-3% higher prices than their rivals.
- In markets without a dominant low-debt firm, prices typically rose after an LBO.
- In markets with a dominant low-debt firm, prices typically fell after an LBO and these price cuts were associated with increased exit of LBO stores.

These papers fit, broadly, into the first category---seeing whether the investments have an effect on competition. This is not direct evidence of strategic investment but rather evidence that rational firms should invest strategically.

Ellison and Ellison, "Strategic Entry Deterrence and the Behavior of Pharmaceutical Incumbents Prior to Patent Expiration," *AEJ: Micro* 2011

Our paper is an example of the second approach.

We identify a qualitative difference between the predictions of strategic and nonstrategic investment models and examine the prediction using data on 63 branded drugs that lost patent protection in 1986-1992.

Note: generic drugs are bioequivalent (chemically identical) competitors that are allowed to enter and compete with branded drugs, typically monopolists, as soon as their patents expire (essentially). Generic drugs typically capture a large market share, often around 90%.

Image by Erin DeMay on flickr. License CC BY-NC-SA

Ellison and Ellison, "Strategic Entry Deterrence and the Behavior of Pharmaceutical Incumbents Prior to Patent Expiration," *AEJ: Micro* 2011

Our paper is an example of the second approach.

We identify a qualitative difference between the predictions of strategic and nonstrategic investment models and examine the prediction using data on 63 branded drugs that lost patent protection in 1986-1992.

Pharmaceutical markets are a useful setting to study strategic investments. In most markets, knowing when potential entry is looming would be very difficult or impossible. (It could, in fact, always be looming, in which case identification of strategic investments would be difficult.) Here, one can look up patent expiration dates.

Ellison and Ellison, "Strategic Entry Deterrence"

Observation 1: Strategic entry deterrence models often predict that the investment-market size relationship will be nonmonotonic. This happens because entry deterrence incentives are strongest in intermediate-sized markets. Deterrence is unnecessary in small markets and impossible in big ones.

Observation 2: Non-strategic models will predict that the relationship is monotone if two effects go in the same direction (and sometimes even if they don't).

The direct effect describes whether marginal investment returns are larger or smaller in larger markets, and the strategic effect describes whether marginal returns are larger or smaller in duopoly versus monopoly markets.

These observations will give us the leverage we need to, at least in theory, differentiate between strategic investment and non-strategic investment---look for nonmonotonicities.

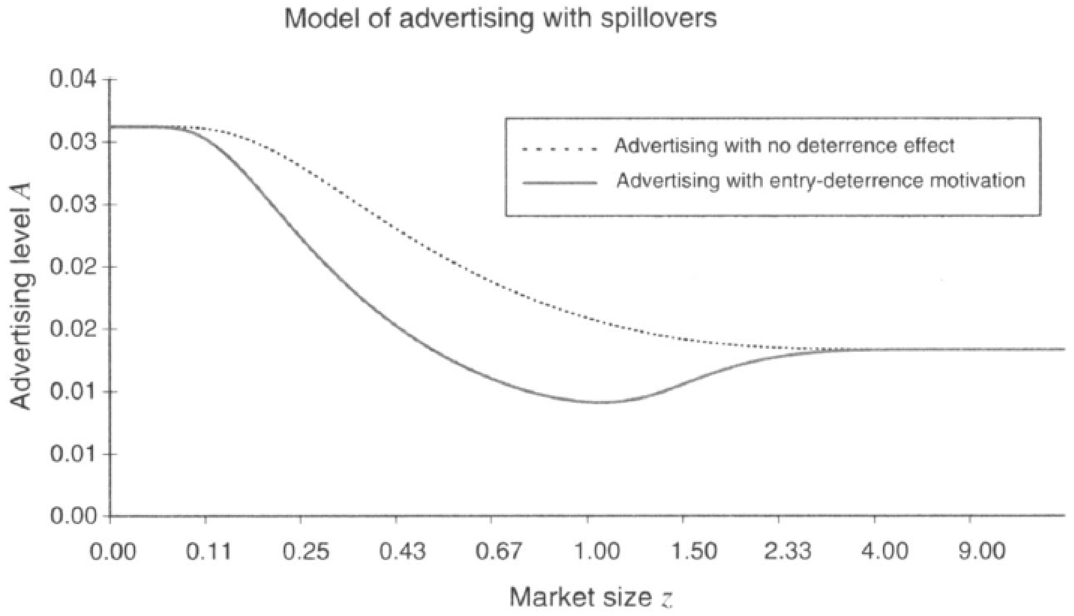
Ellison and Ellison, "Strategic Entry Deterrence"

Example 1 (Targeted Advertising with Spillovers):

Consider a cross section of markets. Suppose that the ith market has a mass z_i of potential consumers, but that the markets are otherwise identical. Let A reflect the per-consumer expenditures on a form of advertising that raises potential consumers' valuations for all products in the product class. More specifically, assume that each market contains consumers with heterogeneous types, θ, distributed uniformly on $[0, 1]$, and that if the monopolist spends $z_i A$ on advertising in market i, a consumer of type θ receives utility $\theta\sqrt{2A} - p_1$ if he buys the (branded) good from firm 1 at price p_1, $(1/2)\,\theta\sqrt{2A} - p_2$ if he buys the (generic) good from firm 2 at price p_2, and zero if he buys neither good.

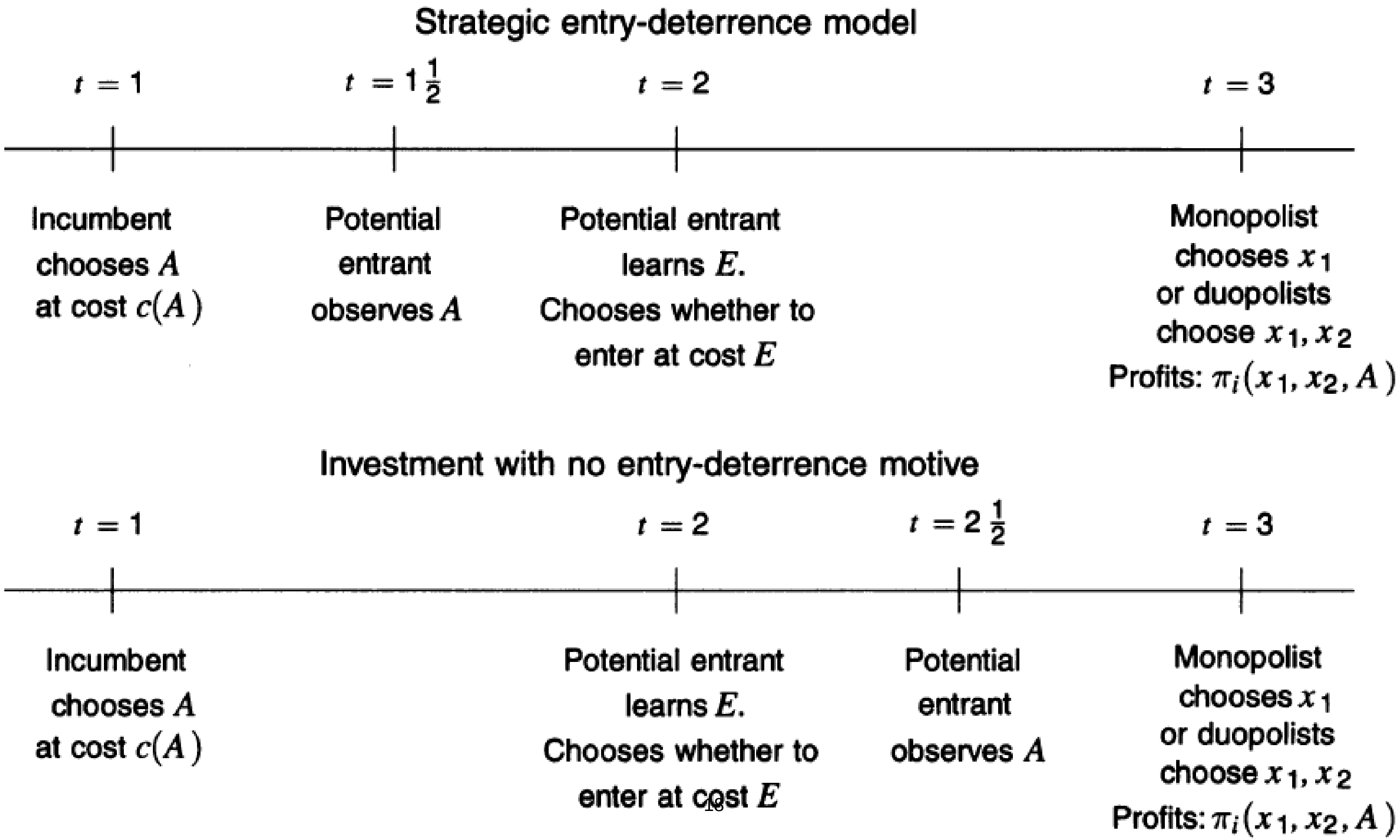
This investment is less valuable if entry occurs because the WTP for firm 2's product also increases. This makes investment that can't affect entry decrease in market size.

The entry deterrence motive makes a strategic firm 1 want price lower in intermediate-sized markets. Keeping demand low makes generic entry less likely.



Ellison and Ellison, "Strategic Entry Deterrence"

The example above compared optimal investment in two models:



Ellison and Ellison, "Strategic Entry Deterrence"

In the model with an entry deterrence motive the actual investment level A affects both the probability of entry and the profits under monopoly/duopoly.

$$E(\pi_1(A)) = F(\pi_2^{d*}(A))\pi_1^{d*}(A) + (1 - F(\pi_2^{d*}(A)))\pi_1^{m*}(A) - c(A).$$

In the model without an entry deterrence motive, the probability of entry is unaffected by actual A, instead reflecting only the equilibrium investment level. We can think of profits as given by the function below:

$$E(\pi_1(A, A^*_{ND})) = F(\pi_2^{d*}(A^*_{ND}))\pi_1^{d*}(A) + (1 - F(\pi_2^{d*}(A^*_{ND})))\pi_1^{m*}(A) - c(A)$$

Ellison and Ellison, "Strategic Entry Deterrence"

As a result, the FOC for the standard entry deterrence model has one extra term:

$$c'(A^*_{ND}) = F(\pi_2^{d*}(A^*_{ND}))\frac{\partial \pi_1^{d*}}{\partial A}(A^*_{ND}) + (1 - F(\pi_2^{d*}(A^*_{ND})))\frac{\partial \pi_1^{m*}}{\partial A}(A^*_{ND})$$

$$c'(A^*_{ED}) = F(\pi_2^{d*}(A^*_{ED}))\frac{\partial \pi_1^{d*}}{\partial A}(A^*_{ED}) + (1 - F(\pi_2^{d*}(A^*_{ED})))\frac{\partial \pi_1^{m*}}{\partial A}(A^*_{ED})$$

$$+ (\pi_1^{d*}(A^*_{ED}) - \pi_1^{m*}(A^*_{ED}))\frac{d\pi_2^{d*}}{dA}(A^*_{ED})f(\pi_2^{d*}(A^*_{ED})).$$

Ellison and Ellison, “Strategic Entry Deterrence”

Observation 1:

The final term in the FOC is typically largest in magnitude in intermediate-sized markets because this is where it is most likely that a small reduction in firm 2’s profits will affect the entry decision.

This can make investment nonmonotonic in market size.

$$\left(\pi_1^{d*}(A_{ED}^*) - \pi_1^{m*}(A_{ED}^*)\right)\frac{d\pi_2^{d*}}{dA}(A_{ED}^*)\underbrace{f(\pi_2^{d*}(A_{ED}^*))}_{\text{likelihood that a small decrease in entrant's profits will be pivotal in their entry decision}}$$

Ellison and Ellison, "Strategic Entry Deterrence"

Observation 2: Some nonstrategic models will have monotonic investment.

Consider a set of markets that differ in their "size" z. Nonstrategic investment changes with z for two reasons. The direct effect reflects whether marginal returns are larger or smaller in large markets. The competition effect reflects whether marginal returns are larger or smaller in duopoly (which is more likely in larger markets).

DEFINITION 1: *The "direct effect" of z on A is* $F(\pi_2^*)\left(\partial^2\pi_1^{d*}/\partial z\partial A\right) + (1 - F(\pi_2^*)) \times \left(\partial^2\pi_1^{m*}/\partial z\partial A\right) - \left(\partial^2 c/\partial z\partial A\right)$.

DEFINITION 2: *The "competition effect" of z on A is* $\left(\partial\pi_1^{d*}/\partial A\right) - \left(\partial\pi_1^{m*}/\partial A\right)$.

PROPOSITION 1: *Let* $A_{ND}^*(z)$ *be the equilibrium investment level in the model of investment absent entry-deterrence motivations described above. Suppose* $(d\pi_2^{d*}/dz) > 0$.[7] *Then* $A_{ND}^*(z)$ *is monotone increasing if the direct and competition effects are positive and* $A_{ND}^*(z)$ *is monotone decreasing if the direct and competition effects are negative.*[8]

Ellison and Ellison, "Strategic Entry Deterrence"

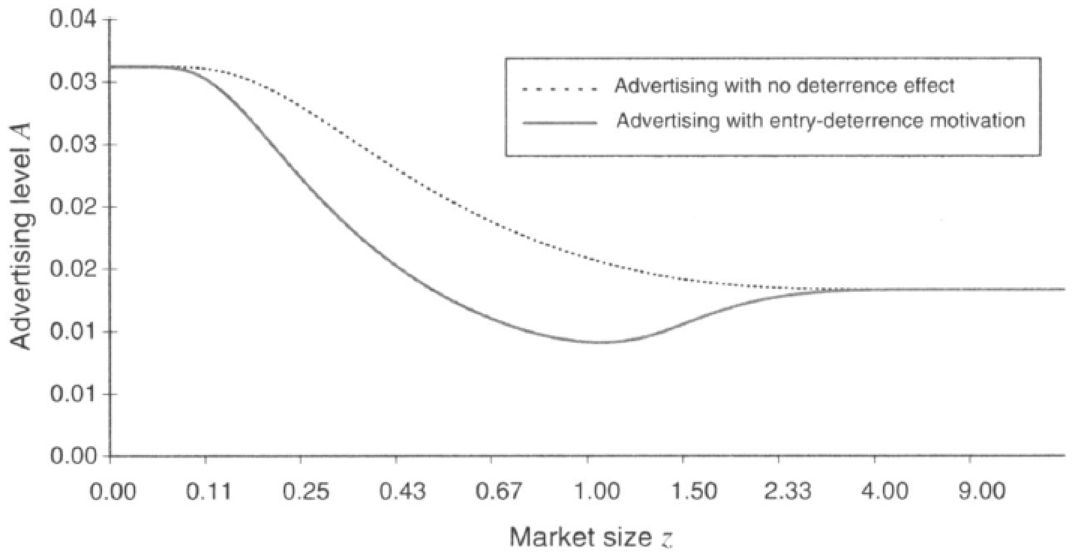
Example 1 (Targeted Advertising with Spillovers):

Consider a cross section of markets. Suppose that the *i*th market has a mass z_i of potential consumers, but that the markets are otherwise identical. Let A reflect the per-consumer expenditures on a form of advertising that raises potential consumers' valuations for all products in the product class. More specifically, assume that each market contains consumers with heterogeneous types, θ, distributed uniformly on $[0, 1]$, and that if the monopolist spends $z_i A$ on advertising in market i, a consumer of type θ receives utility $\theta\sqrt{2A} - p_1$ if he buys the (branded) good from firm 1 at price p_1, $(1/2)\,\theta\sqrt{2A} - p_2$ if he buys the (generic) good from firm 2 at price p_2, and zero if he buys neither good.

Specifying A as having per-consumer costs that provide a per-consumer benefit makes the direct effect of market size zero.

The assumption that the advertising raises valuations for the generic creates the negative competitive effect.

Model of advertising with spillovers



Ellison and Ellison, “Strategic Entry Deterrence”

To turn the observation into something that can be tested, the paper discusses three extensions:

1. Measurement error

   In practice we will observe $A_i = A^*(z_i) + \varepsilon_i$. There is an econometric literature on testing for the monotonicity of an underlying function given such errors.

2. Proxies for z

   In practice the underlying “market size” z_i will be unobservable. Instead we will have some proxy $r_i = z_i + \eta_i$. The paper shows that if η_i has the monotone likelihood ratio property, then $E(A^*(z_i) \mid z_i + \eta_i = r)$ is monotone in r if $A^*(z)$ is monotone in z.

3. Endogeneity of the proxy

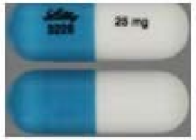
   If the proxy r is endogenous, e.g. $r_i = r(z_i, A_i) + \eta_i$, then things are not as clean, but under some conditions we still have monotonicity.

Ellison and Ellison, “Strategic Entry Deterrence”

We study 63 branded drugs that lost patent protection in 1986-1992. Generic entry dramatically reduces profits, making investment in entry deterrence plausible.

We use revenue in the years prior to patent expiration as a proxy for market size and have data on four potential strategic investments:

- Detail advertising
- Journal advertising
- Presentation proliferation
- Prices

Product Name	Brand Drug	ANDA Generic
Diflucan 150mg (fluconazole 150mg)		
Activella 1-0.5mg (Lopreeza 1-0.5mg) (estradiol & norethindrone acetate)		
EpiPen (Epinephrine auto-injector)		N/A
Strattera 25mg (atomoxetine 25mg)		

Detail and journal advertising need to be treated differently here because their different technologies imply different non-strategic patterns. Journal advertising has a large fixed cost.

Ellison and Ellison, "Strategic Entry Deterrence"

We look for nonmonotonicies of two types:

1. Is A nonmonotone in revenue?
2. Is $A_t - A_{t-2}$ nonmonotone in revenue?

We also examine where in the market size distribution any nonmonotonicity occurs. Entry is most uncertain for drugs in the 2nd quintile of market size, so we look to see if the A's for those drugs are unusually high or low.

right before potential entry

a couple of years before potential entry

Ellison and Ellison, “Strategic Entry Deterrence”

Results:

1. In the cross-section analysis we find that each of the advertising variables is lowest in the second quintile. The nonmonotocities are just marginally significant in our nonparametric tests.

TABLE 6—INCUMBENT BEHAVIOR VERSUS MARKET SIZE: QUINTILE MEANS AND MONOTONICITY TESTS

	Variable mean for drugs in revenue quintile					Monotonicity test *p*-value	
Variable	Q 1	Q 2	Q 3	Q 4	Q 5	H-H test	E-E test
Detail3/Revenue3	0.0051	0.0013	0.0055	0.0084	0.0042	0.197	0.048
Journal3/Revenue3	0.011	0.005	0.011	0.024	0.018	0.080	0.227
PresHerf3	0.78	0.64	0.49	0.44	0.35	0.476	0.917

Ellison and Ellison, "Strategic Entry Deterrence"

Results:

2. In the analysis of investment changes as expiration approaches we find some evidence of nonmonotonicity in the journal advertising and presentation proliferation.

TABLE 7—CHANGES IN INCUMBENT BEHAVIOR AS EXPIRATION APPROACHES: QUINTILE MEANS AND MONOTONICITY TESTS

	Fraction increasing by quintile					Monotonicity test p-value	
	Q 1	Q 2	Q 3	Q 4	Q 5	H-H test	E-E test
Detail3	0.50 (4)	0.11 (9)	0.33 (12)	0.38 (13)	0.38 (13)	0.824	0.221
Journal3	0.00 (2)	0.43 (7)	0.00 (12)	0.14 (14)	0.23 (13)	0.079	0.066
PresHerf	0.33 (6)	0.42 (12)	0.38 (13)	0.50 (14)	0.62 (13)	0.082	0.087
DPrice	0.70 (10)	0.58 (12)	0.75 (12)	0.54 (13)	0.92 (13)	0.356	0.200
HPrice	0.50 (8)	0.50 (12)	0.54 (13)	0.77 (13)	0.73 (11)	0.564	0.678

Goolsbee and Syverson, "How Do Incumbents Respond to the Threat of Entry? The Case of Major Airlines," *QJE* 2008

Image by Tim on flickr. Public domain.

Goolsbee and Syverson, “Threat of Entry”

Goolsbee and Syverson examine whether airlines set lower prices in a city-pair market when the *threat* of entry by Southwest is greater.

Several mechanisms could potentially make low prices a strategic entry-deterring investment: signaling costs; building customer loyalty; signal-jamming about demand elasticities.

The nice feature of their environment is that they can identify shifts in the threat of entry that are unrelated to any changes in current market conditions: the threat of entry on Boston-Indianapolis increases when Southwest first announces that it will be active in both Boston and Indianapolis. Southwest typically announces entry into an airport about 5 months in advance and specifies routes it will initially serve.

One can think of the approach as example of looking for a behavior that would differ between strategic and nonstrategic models.

Goolsbee and Syverson, "Threat of Entry"

$$y_{ri,t} = \gamma_{ri} + \mu_{it} + \sum_{\tau=-8}^{3+} \beta_\tau \,(\text{SW\_in\_both\_airports})_{r,t_0+\tau} + \sum_{\tau=0}^{3+} \beta_\tau \,(\text{SW\_flying\_route})_{r,t_e+\tau} + X_{ri,t}\alpha + \varepsilon_{ri,t},$$

Results:

1. Incumbent prices are lower when Southwest will soon be present in both endpoints.
2. Prices are even lower after Southwest is present, and lower still if Southwest starts serving the route.

	$\ln(P)$
Southwest in both airports (no flights) $t_0 - 8$	−0.030 (0.024)
Southwest in both airports (no flights) $t_0 - 7$	−0.071** (0.030)
Southwest in both airports (no flights) $t_0 - 6$	−0.065* (0.035)
Southwest in both airports (no flights) $t_0 - 5$	−0.079* (0.044)
Southwest in both airports (no flights) $t_0 - 4$	−0.100* (0.049)
Southwest in both airports (no flights) $t_0 - 3$	−0.142** (0.056)
Southwest in both airports (no flights) $t_0 - 2$	−0.132** (0.056)
Southwest in both airports (no flights) $t_0 - 1$	−0.135** (0.065)

Goolsbee and Syverson, “Threat of Entry”

Comments:

1. The argument that predictions differ between strategic and nonstrategic models is not perfectly clean: a shift in entry costs would have a “competiton effect” on investment.

   One could argue that the competition effect might be positive: if an incumbent knows it will lose to Southwest in the future it might decide to consume built up goodwill. But it could go the other way if loyalty increases post-entry market share.

2. Post-entry estimates could potentially be contaminated by data limitations: even when no “entry” in the form of direct (or connecting) service is recorded, some consumers may be flying on Southwest using multiple connections.

Sweeting, Roberts, and Gedge, "A Model of Dynamic Limit Pricing with an Application to the Airline Industry," *JPE* 2020

SRG examine price reductions by Southwest's rivals as strategic limit pricing.

They develop a multiperiod model related to Milgrom-Roberts:

- The incumbent's cost c_{It} follows a Markov process on $[\underline{c}, \overline{c}]$ with positive persistence.
- Southwest's fixed entry cost K_t is drawn iid from density g on $[0, \overline{K}]$.
- At each t incumbent chooses p_{It} and earns profit π_{It}. Southwest observes p_{It} and K_t and chooses In/Out. If it enters there is duopoly competition with commonly observed costs from period $t + 1$ on. Firms play the static NE.

The Markov process creates a perpetual incentive to signal low cost. Incumbents will price below the static monopoly price.

Sweeting, Roberts, and Gedge, "Dynamic Limit Pricing"

The first analysis in the paper is a nonmonotonicity test motivated by the limit pricing model.

The analysis looks at the how prices in 109 markets with a dominant carrier *change* when Southwest becomes a potential entrant.

- The model predicts that prices will drop most in markets with an intermediate entry probability.
- A first stage regression estimates the four-quarter entry probability as a function of market size, concentration, fit with Southwest's network, quarter dummies, etc.
- The second stage regression looks for a nonmonotonic effect of the predicted entry probability $\hat{\rho}_m$ on the price decline:

$$\text{Price Measure}_{j,m,t} = \gamma_{j,m} + \tau_t + \alpha X_{j,m,t} + \ldots$$

$$\beta_0 \text{SWPE}_{m,t} + \beta_1 \widehat{\rho_m} \times \text{SWPE}_{m,t} + \beta_2 \widehat{\rho_m}^2 \times \text{SWPE}_{m,t} + \epsilon_{j,m,t},$$

Sweeting, Roberts, and Gedge, "Dynamic Limit Pricing"

The first analysis in the paper is a nonmonotonicity test motivated by the limit pricing model.

Result: Prices reductions and quantity increases are largest in markets with an intermediate entry probability.

SECOND-STAGE ESTIMATES OF THE RELATIONSHIP BETWEEN THE PROBABILITY THAT SOUTHWEST ENTERS AND CHANGES IN INCUMBENT PRICES, CAPACITIES, SEGMENT TRAFFIC, AND LOAD FACTORS

Dependent Variable	Log Price (1)	Yield (2)	Log Capacity (3)	Log Passengers (4)	Log Load Factor (5)
$SWPE_{m,t}$	−.043*	−.002	.068	.144***	.076***
	(.023)	(.014)	(.043)	(.044)	(.017)
$\widehat{\rho_m} \cdot SWPE_{m,t}$	−.693***	−.732***	.040	.578	.538***
	(.182)	(.142)	(.362)	(.413)	(.142)
$\widehat{\rho_m}^2 \cdot SWPE_{m,t}$	1.169***	1.046***	−.820	−2.053***	−1.233***
	(.256)	(.219)	(.619)	(.749)	(.236)
Observations	3,884	3,884	3,400	3,400	3,400

Sweeting, Roberts, and Gedge, “Dynamic Limit Pricing”

The second analysis calibrates the calibrates the Markov limit pricing model using no information about post entry-threat pricing, shows that the predicted price declines are close to actual price declines, and uses the calibrated model to quantify welfare effects.

The analysis is carried out on 109 markets that had a dominant carrier.

- Demand is assumed to have a nested logit form with the outside good in a separate nest. IV estimates use fuel prices and the incumbent’s endpoint shares.
- Marginal costs for incumbents and Southwest are estimated using FOCs for optimal pricing (before Southwest is a threat and after Southwest enters). Estimate AR(1) on these costs to estimate serial correlation.
- Entry costs are estimated using 20% of the markets. They match predicted and observed entry probabilities.

Sweeting, Roberts, and Gedge, "Dynamic Limit Pricing"

Estimates

1. Demand estimates find close substitutes. After entry the average incumbent own-price elasticity is -2.9.

NESTED LOGIT DEMAND: PRICE AND NESTING PARAMETERS

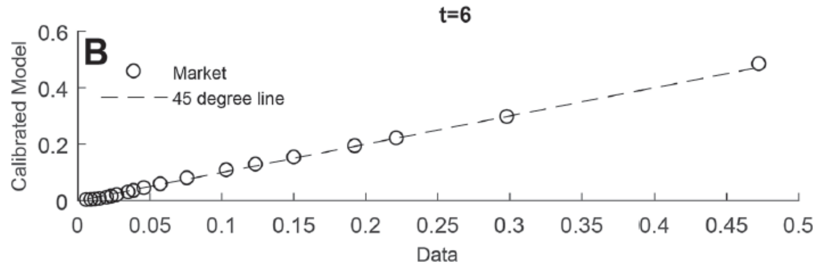
	OLS	2SLS
Fare ($, hundreds; $\hat{\alpha}$)	−.317***	−.446***
	(.011)	(.034)
Inside share ($\hat{\lambda}$)	.748***	.793***
	(.033)	(.072)

2. Marginal costs average $258 for incumbents and $168 for Southwest. Serial correlation is very high.

MARGINAL COST EVOLUTION: ESTIMATES OF SERIAL CORRELATION

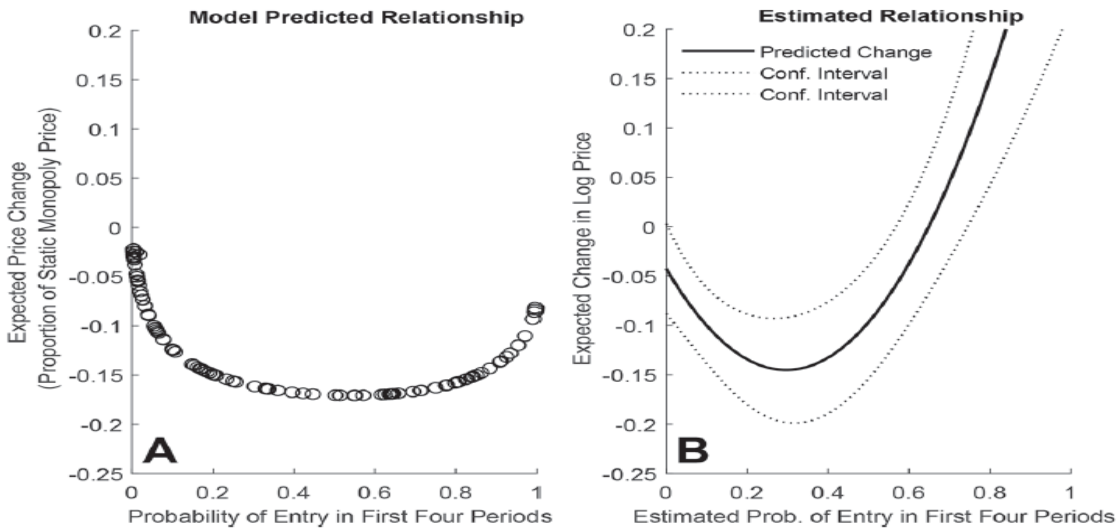
	OLS All Carriers (1)	2SLS All Carriers (2)	2SLS Southwest (3)	2SLS Incumbents (4)
$\widehat{\text{MC per mile}}_{j,m,t-1}$	.916***	.974***	.978***	.962***
	(.037)	(.013)	(.039)	(.012)

3. The calibrated entry costs are able to closely match model-predicted and empirically estimated entry probabilities.



Sweeting, Roberts, and Gedge, “Dynamic Limit Pricing”

The calibrated model does a reasonable job of fitting the magnitude and the cross-sectional pattern of how incumbents reduce reduce prices when threatened with entry.



The calibrated model predicts limit-pricing increases consumer surplus relative to a world with known incumbent costs, particularly in small to medium sized markets.

It also predicts that entry subsidies would substantially increase welfare.

	MARKET			
	Hartford–Minneapolis	Manchester, New Hampshire–Philadelphia	Las Vegas–San Jose	All Dominant Incumbent Markets
Market rank (by rescaled market size, out of 109 markets)	20	65	105	
Actual market size	33,828	45,481	136,861	Total: 5.7 million
Model predictions:				
Second quarter:				
Probability of entry (if no entry in first quarter)	.002	.095	.606	Mean: .151
Shading ($, %; relative to static monopoly price)	20.07, 3.8	86.49, 16.6	57.04, 10.9	Mean: 59.83, 11.4
Twentieth quarter:				
Probability of entry (if no entry previously)	.002	.046	.266	Mean: .050
Shading ($, %; relative to static monopoly price)	16.87, 3.2	69.23, 13.3	117.06, 22.4	Mean: 52.44, 10.1
Probability of entry within four quarters	.010	.339	.973	Mean: .355
Welfare effects of limit pricing (relative to complete information):				
PDV of reduced prices ($, millions)	4.32	6.20	.76	Total: 538.74
PDV of change in consumer surplus ($, millions)	4.38	7.07	.84	Total: 592.27
PDV of change in incumbent profits ($, millions)	−.18	−1.35	−.13	Total: −86.18

Ryan: “The Costs of Environmental Regulation in a Concentrated Industry” *Econometrica* 2012

Ryan’s paper is a structural analysis of the impact of strategic entry deterrence in the cement industry. It assumes that firms react to strategic incentives rather than estimating whether they do, using the assumption to estimate the primitives of a dynamic model.

The primary goal is to evaluate the welfare impact of 1990 Amendments to the Clean Air Act. The new regulations substantially increased entry costs.

A strategic effect of the regulations is that incumbents no longer needed to expand capacity in order to deter entry in their local markets.

The paper is a clean application of the Bajari-Benkard-Levin technique for estimating models of dynamic games. This and related techniques will be covered in detail in 14.273, so we defer the paper to that course.

Next week's topic is bounded rationality.

See you then!