Empirical analysis of markets with free and restricted entry

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Abstract

Empirical entry models provide a fruitful framework to analyze many interesting questions in Industrial Organization. We show how empirical models of free entry can be extended to allow for various kinds of entry restrictions. We first consider a model of regulated entry and a model of monopoly or coordinated entry as alternatives to the free entry model. We then introduce a model that combines elements of both free and coordinated entry. This model describes how an upstream firm may find it optimal to restrict dowstream entry in some markets while allowing for free entry in other markets. The discussion shows how uncovering fixed costs from these alternative entry models is parallel to uncovering marginal costs from alternative oligopoly models of pricing or output behavior. To allow for clear comparisons, we focus on market-level entry models.

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1 Introduction

An important question in Industrial Organization is whether free entry is socially desirable, or whether it is preferable to restrict the number of firms.[1] On the one hand, additional entry promotes competition and increases product diversity. But on the other hand, it also results in a wasteful duplication of fixed costs. The trade-off can be seen most clearly in a Cournot market with homogenous products, where there are no benefits from product diversity. Under free entry, there would be an excessive number of firms as compared to the social optimum, because new entrants do not take into account the business stealing effect on existing firms; see Mankiw and Whinston (1986). In contrast, under monopoly or coordinated entry, there would be insufficient entry because firms do not take into account the market expansion effect from entry. With differentiated products the trade-off becomes more complicated, and there may in principle be insufficient entry even when entry is free. See Spence (1976), Dixit and Stiglitz (1977) and Mankiw and Whinston (1986) for important contributions on free entry and social efficiency.

Empirical entry models can be used to analyze markets characterized by free or restricted entry. Most empirical work since Bresnahan and Reiss (1991) and Berry (1992) has focused on models with free entry. If combined with a variable profit function, these models enable the researcher to uncover fixed costs, closely parallel to how oligopoly models can be combined with a demand side to uncover marginal costs. This is nicely illustrated by Berry and Waldfogel (1999). They estimate demand and uncover fixed costs from entry in the radio broadcasting market. This enables them to quantify the excess number of radio stations relative to the social optimum.

In this paper we show how to extend empirical models of free entry to allow for various kinds of entry restrictions and uncover fixed costs. The analysis of markets with restricted entry allows one to address various interesting questions in industrial organization. Schaumans and Verboven (2008) looked at entry regulation of pharmacies, a common policy in many European countries. Similarly, it is possible to study zoning laws restricting entry in various retail sectors, e.g. Griffith and Harmgart (2008) or Suzuki (2008). Or one can study the (in)efficiency of monopoly coordinated entry, as in the shared ATM network of Ferrari, Verboven and Degryse (2009) or the liquor store public monopoly of Seim and Waldfogel (2009). From a positive perspective, empirical models with entry restrictions enable one to study the vertical control of distribution networks (Ferrari and Verboven, 2009).

[1] "Free entry" refers to a market environment where firms face no external restrictions to entry, so that they enter as long as this is individually profitable. Free entry does not mean costless entry, since firms have to incur fixed costs of entering and staying in the market.

The paper is organized as follows. Section 2 reviews three alternative empirical entry models: free entry, regulated entry and monopoly or coordinated entry. Section 3 introduces a model that combines elements of both free and coordinated entry. This makes it possible to study how an upstream firm controls the size of its distribution network if it does not have sufficient control over wholesale prices or fixed franchise fees to influence entry. To facilitate comparison between different models, we focus on simple market-level models with identical firms. The concluding Section 4 discusses some other recent contributions that make use of location-level and/or firm-level data.

2 Alternative entry models

We concentrate on two-period models of entry; the potential entrants first decide whether or not to enter, possibly subject to entry restrictions, and subsequently make their price or output decisions. Furthermore, we concentrate on market-level models of entry with identical firms. This avoids problems with multiplicity of equilibria in firm-level models of entry.

We start from a cross-sectional data set of markets $i = 1 \cdots I$. For each market i we observe the total number of actual entrants N_i. Furthermore, we have a measure of per-firm variable profits v_i or industry variable profits $V_i = v_i N_i$. Based on this information and a vector of market demographics X_i, we can estimate a per-firm variable profit function $v_i(N_i)$ or an industry variable profit function $V_i(N_i) = v_i(N_i)N_i$. Assume that per-firm variable profits are decreasing in N_i, $v_i'(N_i) < 0$ and that industry variable profits are concave in N_i, $V_i''(N_i) < 0$. For example, one may specify a constant elasticity specification

$$\ln V_i = \ln V_i(N_i) = X_i\beta + \alpha \ln N_i + \xi_i, \tag{1}$$

or

$$\ln v_i = \ln v_i(N_i) = X_i\beta + (\alpha - 1) \ln N_i + \xi_i, \tag{2}$$

where ξ_i is a normally distributed error term, referring to unobserved factors influencing variable profits in market i. The parameter α is the (constant) elasticity of industry variable profits with respect to the number if firms. If α is close to 1, there is mainly market expansion and if α is close to zero there is mainly business stealing from additional entry.

We do not directly observe fixed costs per firm F_i, nor the profits per firm or industry profits. The profits per firm in market i are

$$\pi_i(N_i) = v_i(N_i) - F_i \tag{3}$$

and industry profits in market i are

$$\Pi_i(N_i) = V_i(N_i) - F_i N_i. \tag{4}$$

Although we do not observe fixed costs, we may specify its distribution, for example as

$$\ln F_i = W_i \gamma + \eta_i, \tag{5}$$

where W_i is a vector of market demographics and η_i is a normally distributed error term with mean zero and standard deviation σ. We can draw inferences about the distribution of fixed costs based on an empirical model describing the entry process. This is similar to standard empirical IO practice of drawing inferences about marginal costs from an oligopoly model of pricing or output behavior, but it is complicated by the fact that N_i is a discrete variable.

2.1 Free entry

Suppose first that there is free entry, as in Bresnahan and Reiss (1991), Berry (1992) and most other empirical work on entry. If N_i is a continuous variable, the number of entrants is determined by the zero profit condition $\pi_i(N_i) = 0$. Using (3), fixed costs are simply $F_i = v_i(N_i) = v_i$. Hence, starting from a model of free entry we can trivially uncover fixed costs as per-firm variable profits. We can compare this with the model of perfect competition, where unobserved marginal costs can be uncovered because they are equal to the observed market price.

A practical difficulty is that N_i is not a continuous but rather a discrete variable. In this case it is still possible to uncover bounds on the fixed costs. Upon observing N_i firms under free entry, one can infer that the N_i-th firm can profitably enter the market, whereas the $N_i + 1$-th firm cannot enter profitably, or

$$\pi_i(N_i + 1) < 0 \leq \pi_i(N_i).$$

Using (3), this can be written as

$$v_i(N_i + 1) < F_i \leq v_i(N_i).$$

Because $v_i'(N_i) < 0$, this gives an upper and a lower bound on the fixed costs. The lower bound is simply given by the current variable profits with N_i firms. The upper bound is given by the variable profits if there were one additional firm, $v_i(N_i + 1)$; computing this upper bound therefore requires an estimate of the per-firm variable profit function (2).

Using a log-normal distribution of fixed costs, as in (5), we obtain a standard ordered probit model, where the likelihood of observing N_i firms is

$$\Phi\left(\frac{\ln v_i(N_i) - W_i\gamma}{\sigma}\right) - \Phi\left(\frac{\ln v_i(N_i+1) - W_i\gamma}{\sigma}\right).$$

This model can be estimated simultaneously with a model for per firm or industry variable profits, such as (1) or (2).

Berry and Waldfogel (1999) developed such a model of free entry to assess social inefficiency in U.S. radio broadcasting. Since the marginal costs of broadcasting are zero, variable profits per radio station v_i are simply advertizing revenues per station r_i. Advertizing revenues per station are equal to price per listener multiplied by demand (the number of listeners). Berry and Waldfogel allow both price and demand to depend on the number of stations N_i, and they estimate these equations simultaneously with the ordered probit entry inequalities. They find that there are too many radio stations under free entry (on average 18.6 per market, compared with a socially optimal number of 4.8). Ignoring the value of programming to listeners, this results in a welfare loss of about 30%. Or, from a different perspective, free entry would be justified if the external value of programming to listeners were at least three times its market value (as measured by the advertizing price).

2.2 Regulated entry

In many industries entry is not free but restricted in some form. The entry process should then be described according to the specific features of the market. Cohen and Mazzeo (2007), Griffith and Harmgart (2008) and Suzuki (2008) consider how planning regulations affect entry by bank branches, supermarkets and firms in the lodging industry. These papers model the entry restrictions as directly affecting the firms' payoffs (fixed costs or demand) within a free entry model.

Alternatively, entry restrictions may not affect the firms' payoffs directly and may require modifying the entry model. Schaumans and Verboven (2008) consider the case of pharmacies, who are subject to entry restrictions in many European countries. In Belgium, an establishment act stipulates that there cannot be more than one pharmacy per 2000 inhabitants in small towns (<7500 inhabitants). Similar but even tighter thresholds hold for larger towns. According to the public interest motivation, high (regulated) markups are required to obtain sufficient geographic coverage in otherwise unprofitable rural areas, and the entry restrictions serve to prevent excessive entry in the more profitable areas.

To see how entry regulation may affect fixed costs inferences, let the maximum number of firms in market i be $\overline{N}_i = S_i/2000$, where S_i is the population size in market i. In markets where the actual number of firms is less than the maximum, $N_i < \overline{N}_i$, it is still possible to uncover both an upper and a lower bound on the fixed costs. However, in markets where the entry restriction is binding, $N_i = \overline{N}_i$, one can only infer that the N_i-th firm is profitable, but not that the $N_i + 1$-th firm is unprofitable, since more firms might have wanted to enter if they were allowed to. In these markets one can therefore only uncover an upper bound on the fixed costs. We therefore have

$$v_i(N_i+1) < \quad F_i \leq v_i(N_i) \quad \text{if } N_i < \overline{N}_i$$

$$F_i \leq v_i(N_i) \quad \text{if } N_i = \overline{N}_i.$$

Under the assumption that F_i or $\ln F_i$ is normally distributed, this now gives rise to a censored ordered probit model.

Schaumans and Verboven (2008) estimate a variant of this model (also allowing for strategic complementarities between the pharmacies' and physicians' entry decisions). To evaluate the public interest motivation of the regulation they subsequently ask what would happen to geographic coverage of pharmacies under a combined policy of lowering the regulated markups and relaxing the entry restrictions. They find, for example, that doubling the maximum number of pharmacies per market and at the same time lowering the regulated markups to 43% of the original level would leave the total number of pharmacies in the country constant and would only imply a small reduction in geographic coverage (in the sense of markets without a pharmacy). Hence, the public interest motivation for the establishment act has no empirical support, and a liberalization could result in a major shift in rents from pharmacies to consumers.

2.3 Monopoly or coordinated entry

The previous example considered an industry with market-specific entry restrictions that are exogenously given, in this case according to the deterministic rules of an establishment act. In other industries entry restrictions may be endogenous, i.e. determined by a decision maker who takes into account the local characteristics of each market. A simple model of endogenous entry restrictions is one of monopoly or coordinated entry, where the decision maker sets the number of firms in each market i to maximize industry profits, $\Pi_i(N_i) = N_i\pi_i(N_i)$, as given by (4).

If N_i is a continuous variable, the equilibrium number of entrants now satisfies the first-order condition for industry profits, $\Pi_i'(N_i) = 0$, instead of the earlier zero profit condition, $\pi_i(N_i) = 0$. Using (4), one can then uncover fixed costs as $F_i = V_i'(N_i)$. Note that uncovering fixed costs from marginal industry variable profits (with respect to N_i) is parallel to Rosse's (1970) idea to uncover marginal costs from marginal revenues (with respect to output). Whereas uncovering fixed costs requires an estimate of the elasticity of industry variable profits with respect to N_i (e.g. based on (1)), uncovering marginal costs requires an estimate of the price elasticity of demand.

The discrete nature of N_i requires modifying the first-order condition to a set of inequalities. From observing N_i firms we can infer that the marginal joint profits for the N_i-th firm are positive, whereas the marginal joint profits for the $N_i + 1$-th firm are negative, or

$$\Pi_i(N_i + 1) - \Pi_i(N_i) < 0 \leq \Pi_i(N_i) - \Pi_i(N_i - 1).$$

Using (4), this can be written as

$$V_i(N_i + 1_i) - V_i(N_i) < F_i \leq V_i(N_i) - V_i(N_i - 1).$$

Because industry profits are concave in N_i, $V_i^{''}(N_i) < 0$, this gives a lower and an upper bound on the fixed costs. While the bounds are evidently different from those in the free entry model, the model's structure is similar. Under the assumption that F_i or $\ln F_i$ are normally distributed we again obtain an ordered probit model.

Ferrari, Verboven and Degryse (2009) consider such a model to analyze the Belgian banks' coordinated decisions to set the number of shared ATMs per market. In their setting there are no retail fees for cash withdrawals at ATMs or branches. The main profit motive for investing in ATMs consists of the variable cost savings from consumer substitution out of expensive branch transactions. More specifically, the variable profits from ATMs, $V_i(N_i)$, are equal to ATM transaction demand, multiplied by the unit cost saving from having an ATM rather than a branch transaction. Ferrari, Verboven and Degryse (2009) estimate an ATM transaction demand equation (increasing in ATM density N_i) simultaneously with the ordered probit entry inequalities, which describe the trade-off between industry variable profits and fixed costs. They find that the coordinating banks substantially underinvested in ATM coverage across markets. Yet the main welfare losses are not due to this underinvestment, but rather stem from an insufficient usage of the existing ATM network because banks are not allowed to charge fees for branch transactions.

3 A model combining free and coordinated entry

The above examples show how one can go beyond standard models of free entry to address questions about regulated and coordinated entry. We now introduce a setting where there is neither pure free entry nor pure coordinated entry, but rather a combination of the two. This setting emerges when an upstream firm wants to control the size of its distribution network, but does not have sufficient control over wholesale prices or fixed franchise fees to achieve the first-best number of retail entrants. In this setting, the upstream firm finds it optimal to allow free entry in some markets, but restrict entry in other markets to prevent cannibalization or encroachment. Based on this intuition, Ferrari and Verboven (2009) develop a model of vertical control in detail and apply it to magazine distribution.

There is an upstream firm selling magazines through a network of downstream retail outlets. The upstream firm's profits in market i are

$$\Pi_i^U(N_i, \omega_i) = \omega_i V_i(N_i) - \delta F_i N_i \tag{6}$$

and a downstream retail outlet's profits are

$$\pi_i^D(N_i, \omega_i) = (1 - \omega_i) v_i(N_i) - (1 - \delta) F_i. \tag{7}$$

Here, ω_i is the upstream firm's variable wholesale margin in market i as a percentage of the total variable margin of the upstream and downstream firm. It is therefore the fraction of variable profits that goes to the upstream firm. Similarly, δ is the fraction of the fixed costs borne by the upstream firm. We assume δ is constant across all markets. Total profits in the market are therefore

$$\Pi_i(N_i) = \Pi_i^U(N_i, \omega_i) + N_i \pi_i^D(N_i, \omega_i) = V_i(N_i) - F_i N_i, \tag{8}$$

which is the same as equation (4) before.

If the upstream firm can set a market-specific wholesale margin ω_i, it can simply choose the first-best number of outlets per market, maximizing (4) or (8). It can extract all profits by setting the highest ω_i such that the first-best number of firms can just profitably enter. In sum, with a market-specific wholesale margin ω_i, the upstream firm can obtain the first-best number of outlets and the empirical model is the one of coordinated entry considered before.

But in practice the upstream firm may not be able to set market-specific wholesale margins. Suppose that the wholesale margin cannot be tailor made to the local circumstances, so it is uniform across all markets, $\omega_i = \omega$. Given ω, the upstream firm faces the following constrained maximization problem in each market i:

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

To simplify, suppose that N_i can be treated as a continuous variable.

The solution to this problem is one of the following possibilities: (i) $\frac{\partial \Pi_i^U(N,\omega)}{\partial N_i} = 0$ and $\pi_i^D(N_i, \omega) > 0$, or (ii) $\frac{\partial \Pi_i^U(N_i,\omega)}{\partial N_i} > 0$ and $\pi_i^D(N_i, \omega) = 0$. In the first case, there will be restricted entry in market i: given ω, the upstream firm finds it optimal to directly restrict the number of retail outlets, who all earn positive rents. In the second case, there will be free entry in market i as the retail outlets' profit constraints are binding: given ω, the upstream firm would like more firms to enter (since its marginal profits are still positive), but this is not profitable for the outlets.

We can use (6) and (7) to write the two possible first-order conditions compactly as

$$\min\left\{\frac{\omega}{\delta}V_i'(N_i), \frac{1-\omega}{1-\delta}v_i(N_i)\right\} = F_i. \tag{9}$$

This condition shows how fixed costs can be uncovered from either the restricted or the free entry condition, depending on which is lower. If the first part in braces is lower, there will be restricted entry; otherwise there will be free entry. Intuitively, the upstream firm wants to restrict entry in markets where an additional entrant creates insufficient market expansion ($V_i'(N_i)$ small) to compensate for the upstream firm's part of the fixed costs (δF_i).

Ferrari and Verboven (2009) develop the models with market-specific and uniform wholesale margins in more detail to assess how a magazine publisher controls its distribution network. They find that a market-specific wholesale margin (which yields first-best profits) would raise profits to only a moderate extent relative to the case of a uniform wholesale margin. A uniform margin also implies the presence of restricted entry in a significant number of markets, mostly in markets where there are 2 or more retail outlets.

4 Concluding remarks

Empirical models of entry provide a fruitful framework to analyze many questions of applied interest in Industrial Organization, extending well beyond the questions addressed using free entry models. We showed how suitable models can be developed to study problems of entry regulation, monopoly or coordinated entry, and vertical control of distribution networks.

We focused our discussion exclusively on market-level models of entry. This allowed for a clear comparison of alternative modeling approaches. In practice, it is possible to relax these assumptions and enrich the entry process in various ways. First, spatial aspects of location within a market can be incorporated. Seim and Waldfogel (2009) provide an analysis of store location decisions by the Pennsylvania state-run liquor store monopoly. They estimate a spatial demand model. But because of the increased computational complexity, they do not infer fixed costs from an entry model but rather use an outside estimate. They then assess whether the observed entry patterns are more consistent with the objective of profit or welfare maximization. Ferrari (2009) also estimates a spatial demand model and infers the fixed cost of installing an ATM using Pakes et al.'s (2006) moment inequalities approach.

Second and relatedly, entry at the firm-level rather than at the market-level can be considered. Several recent papers model multiple competing firms, each of which can invest in multiple outlets. For example, Ishii (2005) considers banks' decisions on the number of ATMs. Suzuki (2008) considers chains' decisions to open multiple hotels. Jia (2007) considers supermarket chains' decisions whether or not to open a stores across different markets; Nishida (2009) generalizes this to allow for opening multiple stores across different markets. These applications can be viewed as generalizations of the monopoly entry model, each using alternative econometric approaches to deal with the increased complexity of the problem.

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