A Note on Free Entry under Uncertainty: the Role of Asymmetric Information *

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Abstract

In a model of competing managerial firms I show that the equilibrium number of firms decreases with uncertainty if entry is relatively more costly than monitoring. The result adds to the earlier contributions and is consistent with the available evidence.

Keywords. asymmetric information, free entry, uncertainty, managerial firms.

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1 Introduction

Models where risk-neutral firms compete in prices predict that greater uncertainty about marginal costs spurs entry. This is because profit functions are convex in prices, and (expected) prices are increasing with respect to cost volatility. Yet, the empirical evidence seems to support the opposite view — see, e.g., Ghosal (1996) and (2007).

To explain this puzzle the existing literature has mainly focused on risk aversion: more risk averse firms prefer not to operate in markets featuring high price uncertainty. But, these models are unable to provide unambiguous and easily testable predictions (e.g., Appelbaum and Katz, 1986, and Haruna, 1996). And, even when they do provide clear-cut results, these findings are not in line with the evidence (e.g., Jellal and Wolff, 2005). Moreover, they usually neglect agency issues and are mute on the interplay between managerial rents, corporate control and entry decisions. Modern firms, even small companies, typically feature agency conflicts that shape managerial incentives and,

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in turn, industry structure and performance. What are the drivers of managerial firms' entry and exit decisions? What is the impact of organizational and contractual rules on industry structure?

To address these issues, I analyze a simple managerial model linking entry decisions, corporate control and uncertainty. My purpose is to emphasize that, even under risk neutrality, a negative relationship between entry and uncertainty obtains when asymmetric information plagues the conflict between ownership and control. In a model where pricing, corporate control and entry decisions are determined endogenously, I show that the effect of uncertainty on the equilibrium number of firms is shaped by the relative magnitude of monitoring and entry costs. Using a simple setting where managers are privately informed about (constant) marginal costs of production, I show that the equilibrium number of firms is decreasing in a measure of uncertainty if monitoring costs are smaller than entry costs, and the converse obtains otherwise.

The main trade-off is as follows. First, greater uncertainty increases the average market price and this spurs entry because sales profits are convex in prices: *a price effect*. Second, greater uncertainty spurs the information rent that shareholders must give up to induce truthful information revelation, this stifles shareholders' total profits and makes entry less convenient: *a rent effect*.

The net effect depends on the relative magnitude of entry and monitoring costs. If entry costs are larger than monitoring costs, the rent effect dominates: more uncertainty spurs information rents and entry becomes less worthwhile because shareholders get lower returns from their initial investment — a result in line with the evidence reported in Ghosal (2007). Conversely, if monitoring costs are larger than entry costs, the price effect dominates. In this case shareholders have little direct control on managers: the only way to reduce costly information rents is to distort upward prices in bad technological states (to make mimicking less profitable). This distortion magnifies price dispersion and strengthens the positive effect of uncertainty on entry.

Summing up, this trade-off is novel in the literature and offers simple testable predictions on the link between entry and uncertainty which provide ready to use guidelines for interpreting and designing future empirical investigations.

2 The model

Consider a Salop (1979) model where n firms are positioned symmetrically around a circle with perimeter equal to 1. The entry cost is F. Firms produce the same product and compete in prices. The circle is populated by a continuum of consumers with a uniform density of 1. Each consumer buys one unit of the good. If a consumer located at $x \in (z_i, z_{i+1})$ purchases from firm i located at z_i, his utility is

$$V_i(x) = v - p_i - tx,$$

where v is the reserve price of each consumer — i.e., the utility of consuming the most preferred variety x — and tx is the (linear) disutility associated with consuming this variety.

Each firm features separation between ownership and control (see, e.g., Hart, 1983, Scharfstein, 1988, Schmidt, 1997, and Raith, 2003). Shareholders (principals) own all productive assets, but lack the required expertise in managing them, so they need to employ self-interested managers (agents) to run business in their behalf. Managers set prices and collect profits, which are then distributed to shareholders.

Production technologies are linear: marginal costs are determined by the realization of a random variable $\widetilde{\theta}_i \in \Theta = \left\{\overline{\theta}, \underline{\theta}\right\}$, with $\Pr\left(\underline{\theta}\right) = \nu$ and $\Delta\theta = \overline{\theta} - \underline{\theta} > 0$ for all i. Managers privately observe marginal costs and are protected by limited liability.

Shareholders hire managers before production occurs and uncertainty is resolved, they have full bargaining power and make take-it-or-leave-it offers. I use the Revelation Principle to characterize the set of incentive feasible allocations: once uncertainty is resolved, a *message* game takes place within each firm. A managerial contract C_i specifies an allocation rule determining: (i) the final price, p_i, (ii) the dividend to shareholders, D_i, and (iii) an auditing scheme, featuring a monitoring probability, ϕ_i, and and a (monetary) punishment, P_i, enforced if a lie is detected. Auditing the manager is expensive and it costs $c\left(\phi_i\right)$ to shareholders. I shall interpret the probability ϕ_i as a measure of monitoring (corporate control) intensity.

Shareholders can fully commit to a costly state verification policy. Hence, contract C_i is a mechanism

$$C_i = \left\{p_i\left(m_i\right), D_i\left(m_i\right), \phi_i\left(m_i\right), P_i\left(\theta_i\right)\right\}_{\left(\theta_i, m_i\right)\in\Theta^2}$$

specifying a price, $p_i\left(m_i\right)$, a dividend, $D_i\left(m_i\right)$, and an auditing probability, $\phi_i\left(m_i\right)$, all contingent on manager i's report $m_i \in \Theta$. C_i also specifies a punishment $P_i\left(\theta_i\right)$, contingent on the true type θ_i, which is enforced whenever $\theta_i \neq m_i$. Upon receiving the message m_i, shareholders audit the manager with probability $\phi_i\left(m_i\right)$, discover the state θ_i and, if a lie is detected, the punishment $P_i\left(\theta_i\right)$ is inflicted to manager i.

The game unfolds as follows,

- $\mathbf{T = 0}$. Shareholders decide whether to enter the market.

- $\mathbf{T = 1}$. Shareholders *secretly* propose contracts to managers. If an offer is rejected, both parties enjoy an outside option normalized to zero.

- $\mathbf{T = 2}$. Uncertainty resolves and a *message* game takes place within each firm: managers report their private information, set prices and product market competition takes place.

- $\mathbf{T = 3}$. Profits materialize, shareholders audit managers, dividends and punishments (if any) are collected.

Since contracts are secret, the equilibrium concept is Perfect Bayesian Equilibrium (PBE) with a "passive beliefs" refinement: given an equilibrium where shareholders of firm i offer the contract C_i^e ($i = 1, .., n$), when manager i is offered an unexpected contract, $C_i' \neq C_i^e$, he still believes that rivals are offered the equilibrium contracts — i.e., $C_j = C_j^e$ for any $j \neq i$. I shall look for a symmetric separating PBE: firms with the same cost charge the same price ($p_i(\theta_i) = p_j(\theta_j)$ for $\theta_i = \theta_j$) and prices are type-dependent ($p_i(\theta_i) \neq p_i(\theta_i')$ if $\theta_i \neq \theta_i'$).

Let $p^e(\theta_i)$ be firm i's equilibrium price in state θ_i. Consider firm i setting p_i when its neighbors charge the equilibrium prices $p^e(\theta_j)$ ($j \in \{i+1, i-1\}$). The location of the consumer that is indifferent between purchasing from firm i or its neighbor $i+1$, $x(p_i, p^e(\widetilde{\theta}_{i+1}))$, is defined by the indifference condition

$$v - p_i - tx = v - p^e(\theta_{i+1}) - t\left(\frac{1}{n} - x\right) \Rightarrow x(p_i, p^e(\theta_{i+1})) = \frac{p^e(\theta_{i+1}) - p_i + \frac{t}{n}}{2t}.$$

By symmetry, firm i's expected demand is

$$\sum_{j\in\{i+1,i-1\}} \mathrm{E}_{\widetilde{\theta}_j}[x(p_i, p^e(\widetilde{\theta}_j))] = \sum_{j\in\{i+1,i-1\}} \frac{\mathrm{E}_{\widetilde{\theta}_j}[p^e(\widetilde{\theta}_j)] - p_i + \frac{t}{n}}{2t} = \frac{\widehat{p}^e - p_i + \frac{t}{n}}{t},$$

where $\widehat{p}^e \equiv \mathrm{E}_{\widetilde{\theta}_j}[p^e(\widetilde{\theta}_j)]$ is the average (equilibrium) price. Manager i's (expected) utility is linear in wealth

$$U(\theta_i, m_i) = \mathrm{E}_{\widetilde{\theta}_{i+1},\widetilde{\theta}_{i-1}}[U_i(\theta_i, m_i|\theta_{i+1}, \theta_{i-1})] = Q^i(p_i(m_i), \widehat{p}^e)(p_i(m_i) - \theta_i) - D_i(m_i) - \phi_i(m_i) P_i(\theta_i),$$

Shareholders are risk-neutral and maximize expected dividends $\mathrm{E}_{\widetilde{\theta}_i}[D_i(\widetilde{\theta}_i)]$.

Technical assumptions:

A1 $\widetilde{\theta}_i$ takes values $\overline{\theta} = 1 + \sigma$ and $\underline{\theta} = 1 - \sigma$ with equal probability — i.e., it has a standard deviation of $\sigma \in [0, 1]$, an expected value of 1, and a support $\Delta\theta = 2\sigma$. The monitoring cost is quadratic: $c(\phi) = \psi\phi^2/2$, with $\psi > 0$.

Hence, while $\widetilde{\theta}_i$ reflects an idiosyncratic shock to each firm, σ measures industry-wide uncertainty. Results will be derived for σ small to avoid corners.

3 Complete information benchmark

Suppose that shareholders observe their own manager's cost, but not those of the rivals' managers. Then,

Lemma 1 *Assume **A1** and σ small. The equilibrium number of firms is*

$$n^*(\sigma) \simeq \frac{\sqrt{tF}}{F} + \frac{\sigma^2\sqrt{tF}}{4tF^2},$$

with $\frac{\partial n^*(\sigma)}{\partial \sigma^2} > 0$.

Sales profits are convex in prices, therefore greater uncertainty makes entry more profitable.

4 Asymmetric information

Consider now asymmetric information. I look for a symmetric separating equilibrium of the game where: (i) shareholders offer contracts inducing truthful revelation by managers and that are best response one to another; (ii) managers participate the game and truthfully report their types; (iii) the equilibrium number of firms is determined by the shareholders' (expected) zero profit condition. An equilibrium with these features must satisfy the following conditions:

First, manager i accepts contract C_i if his participation constraint holds,

$$U_i(\theta_i) = Q^i(p_i(\theta_i), \widehat{p}^e)(p_i(\theta_i) - \theta_i) - D_i(\theta_i) - \phi_i(\theta_i) P_i(\theta_i) \geq 0, \quad \forall\, \theta_i \in \Theta. \tag{1}$$

Second, truthful reporting requires the Bayesian incentive compatibility to hold, i.e.,

$$U_i(\theta_i) \geq Q^i(p_i(m_i), \widehat{p}^e)(p_i(m_i) - \theta_i) - D_i(m_i) - \phi_i(m_i) P_i(\theta_i), \quad \forall\, m_i \neq \theta_i. \tag{2}$$

Finally, since managers are protected by limited liability, the punishment $P_i(\theta_i)$ must imply

$$D_i(m_i) + P_i(\theta_i) \leq Q^i(p_i(m_i), \widehat{p}^e)(p_i(m_i) - \theta_i), \quad \forall\, m_i \neq \theta_i, \tag{3}$$

meaning that at the most the firm cash flow can be seized by shareholders when a lie is detected.

The equilibrium contract C^e then solves:

$$C^e = \arg\max_{C_i} \begin{cases} \mathrm{E}_{\widetilde{\theta}_i}\left[Q^i(p_i(\widetilde{\theta}_i), \widehat{p}^e)(p_i(\widetilde{\theta}_i) - \widetilde{\theta}_i) - U_i(\widetilde{\theta}_i) - c(\phi_i(\widetilde{\theta}_i))\right], \\ \text{subject to (1)-(3).} \end{cases}$$

Standard techniques (see, e.g., Laffont and Martimort, 2000) imply that the relevant incentive constraint is that of efficient types, i.e.,

$$\underline{U}_i \geq \overline{U}_i + \Delta\theta Q^i(\overline{p}_i, \widehat{p}^e) - \overline{\phi}_i \underline{P}_i. \tag{4}$$

Efficient managers mimic inefficient ones simply because, by doing so, they save on production costs. Hence, limited liability implies

$$\underline{P}_i \leq \overline{U}_i + \Delta\theta Q^i(\overline{p}_i, \widehat{p}^e). \tag{5}$$

Note that, in equilibrium, there is no need to audit a manager claiming to be efficient — i.e., $\underline{\phi}_i = 0$. This is because the inefficient type's incentive constraint is slack and auditing is costly. Inefficient managers get no rents ($\overline{U}_i = 0$) so that the punishment $\overline{P}_i$ in the inefficient state is irrelevant. Differently, the punishment in the efficient state $\underline{P}_i$ is the largest possible given (5), i.e.,

$$\underline{P}_i = \Delta\theta Q^i\left(\overline{p}_i, \widehat{p}^e\right).$$

Hence,

$$\underline{U}_i \geq \left(1 - \overline{\phi}_i\right)\Delta\theta Q^i\left(\overline{p}_i, \widehat{p}^e\right).$$

This expression determines the information rent as a function of two endogenous variables: the monitoring intensity $\overline{\phi}_i$ and the price $\overline{p}_i$ charged in the inefficient state. The cost of inducing managers to tell the truth decreases the larger is the monitoring intensity (high $\overline{\phi}_i$) and the smaller is firm i's expected demand in state $\overline{\theta}$. To reduce this rent shareholders will: (i) monitor managers claiming to be inefficient with positive probability; (ii) distort upward the price $\overline{p}_i$ relative to the complete information benchmark.

Principal i's objective is therefore:

$$\max_{p_i(.),\overline{\phi}_i} \mathrm{E}_{\widetilde{\theta}_i}[Q^i(p_i(\widetilde{\theta}_i), \widehat{p}^e)(p_i(\widetilde{\theta}_i) - \widetilde{\theta}_i)] - \nu(1-\overline{\phi}^e)\Delta\theta Q^i\left(\overline{p}_i, \widehat{p}^e\right) - (1-\nu)\, c(\overline{\phi}_i).$$

Optimizing with respect to prices and monitoring intensity, a symmetric equilibrium (with interior solutions) is identified by the first-order conditions

$$\frac{\partial Q^i(\underline{p}^e, \widehat{p}^e)}{\partial \underline{p}_i}(\underline{p}^e - \underline{\theta}) + Q^i(\underline{p}^e, \widehat{p}^e) = 0, \tag{6}$$

$$\frac{\partial Q^i\left(\overline{p}^e, \widehat{p}^e\right)}{\partial \overline{p}_i}\left(\overline{p}^e - \overline{\theta}\right) + Q^i\left(\overline{p}^e, \widehat{p}^e\right) - \frac{\nu}{1-\nu}(1-\overline{\phi}^e)\Delta\theta\frac{\partial Q^i\left(\overline{p}^e, \widehat{p}^e\right)}{\partial \overline{p}_i} = 0, \tag{7}$$

$$\frac{\nu}{1-\nu}\Delta\theta Q^i\left(\overline{p}^e, \widehat{p}^e\right) - c'(\overline{\phi}^e) = 0. \tag{8}$$

As standard, low-cost managers price according to the efficient rule, (expected) marginal revenues equalize marginal costs as stated by equation (6). High cost managers, instead, are forced to set prices according to an inefficient rule as implied by equation (7): shareholders realize that the information rent of the efficient manager is larger the higher is demand when he mimics, so they request a larger price in the bad state to reduce this rent. Finally, equation (8) states that the monitoring intensity is chosen so as to equalize marginal costs to marginal benefits, which are captured by the negative impact of a tighter control on rents.

The free entry condition is:

$$\underbrace{\mathrm{E}_{\widetilde{\theta}_i}[Q^i(p^e(\widetilde{\theta}_i), \widehat{p}^e)(p^e(\widetilde{\theta}_i) - \widetilde{\theta}_i)]}_{\text{Sales profits}} = \underbrace{\nu(1-\overline{\phi}^e)\Delta\theta Q^i\left(\overline{p}^e, \widehat{p}^e\right)}_{\text{Expected rents}} + \underbrace{(1-\nu)\, c(\overline{\phi}^e)}_{\text{Monitoring costs}} + \underbrace{F}_{\text{Entry costs}}. \tag{9}$$

This condition implies that, in a competitive equilibrium, shareholders equalize sales profits to total costs, which include managerial rents, monitoring costs and entry costs.

Using the parametric specification in **A1** and taking σ small, the solution of the system of equations (6), (7), (8) and (9) implies the following result:

Proposition 2 *Assume **A1** and σ small. The equilibrium number of firms with asymmetric information is*

$$n^e(\sigma) \simeq \frac{\sqrt{tF}}{F} + \frac{\sigma^2(\psi - F)\sqrt{tF}}{2\psi t F^2},$$

with

$$sign\frac{\partial n^e(\sigma)}{\partial \sigma^2} = sign(\psi - F).$$

The solution is interior, i.e.,

$$\overline{\phi}^e(\sigma) \simeq \frac{2\sigma}{\psi}\left[\frac{F}{\sqrt{Ft}} - \frac{\sigma}{t}\right] < 1.$$

Larger cost volatility has two countervailing effects on entry. First, greater uncertainty increases the average price and this encourages entry because sales profits are convex in prices. Second, greater uncertainty increases the information rent that owners give up to induce truthful information revelation, this stifles profits thereby making entry less profitable.

Which effect prevails depends on the relative magnitude of entry and monitoring costs. If the entry cost (F) is larger than the monitoring cost (ψ), the rent effect dominates. Greater uncertainty spurs information rents and entry becomes more costly; hence, shareholders get lower returns from their sunk investment: a result echoing the evidence found in Ghosal (2007). Conversely, if the monitoring cost is larger than the entry cost, the price effect dominates. This is because, when monitoring is very costly shareholders have little direct control over managers: the only way to reduce the costly information rents is to distort upward the price in the bad state. This distortion magnifies the equilibrium price dispersion and therefore strengthens the positive effect of uncertainty on entry.

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