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Signaling Rather than Incentive Mechanism for Entry Regulation

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Abstract

The lack of complete information has been considered as a barrier to the optimal regulation. This paper shows that this is true for price regulation, but not for entry regulation. The performance of an entry regulation under asymmetric information can be better than that under complete information, if the government uses signaling mechanism rather than incentive mechanism. The main difference between screening and signaling is who initiates information transmission process. Contrary to the incentive mechanism for the optimal price regulation, the signaling mechanism induces the regulated firm to deviate from the monopoly behavior to signal itself and to trigger entry regulation. As a result, the social welfare under asymmetric information can be even higher than under complete information.

JEL Classification: D82, L51

Keywords: asymmetric information, entry regulation, signaling, incentive mechanism

1. Introduction.

Since the seminal works by Akerlof(1970), Rothschild and Stiglitz(1976), Spence(1973), and some others, asymmetric information has been considered as a major source of market failure. Adverse selection and moral hazard problems either make it impossible for a market to reach an equilibrium, or make the market equilibrium under asymmetric information suboptimal compared to the case of full information.

Consider Spence(1973)'s job market signaling model as an example. The equilibrium in Spence's model is inefficient because of the excess education by the worker. Education is socially wasteful since it doesn't increase worker's productivity, but only plays the role of signaling. If information were complete, the socially costly education would not be necessary. The only reason for a worker to invest into education was to signal himself under asymmetric information.

However, what if the market signaling is through donation instead of education? There is no difference between donation and education in terms of signaling effect since any costly action can be a signaling device. However, donation surely contributes to the social welfare contrary to education.[1] If workers use donation, instead of education, as the signaling device, the equilibrium in the job market signaling model will not be suboptimal any more. Actually if we assume that one-dollar donation contributes more than one-dollar to the whole society, then excess donation, not excess education, will make social welfare under incomplete information even higher than that under complete information.[2]

The possibility of welfare improvement under incomplete information is already demonstrated, for example, in Milgrom and Roberts(1982). In Milgrom and Roberts, particularly in the separating equilibrium, the more efficient type of incumbent firm chooses a lower price than the monopoly level to transmit information to the potential entrant and to discourage its entry. Since there would have also been no entry under complete information, the social welfare improves under incomplete information due to the lowered monopoly price in the pre-entry stage.[3] Even though Milgrom and

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1) Even though education may also contribute to the social welfare in reality, we just follow the assumption in Spence. If we restrict the boundary of an economy to the workers and the firm, then we can interpret donation as, for example, the capital investment which lowers firm's production cost and raises profit by more than donation by the workers.

2) The possibility of the multiplying effect of donation is the counterpart of the distortionary tax in regulation theory. See Laffont and Tirole(1993) for the regulation analysis under the assumption of distortionary public fund; the social cost of one-dollar tax is more than one-dollar. If donation saves public spending, that is, if it reduces tax, then donation is surely welfare increasing.

Roberts do not stress the possibility of welfare improvement under asymmetric information as the main result, they surely point out this important issue in relation to the public policy.

Is the same result possible in government regulation? In other words, can government do better under asymmetric information than under full information in regulations? Contrary to the free market interactions, the issue in regulations is maximizing social welfare without constraint or with constraint by the benevolent dictator. Therefore, it seems trivial that the government can do better without a constraint of asymmetric information. The theory of optimal monopoly regulation under asymmetric information confirms such predictions.[4] The standard trade-off between rent extraction and incentive provision implies that the optimal regulation under asymmetric information can only be the second-best, not the first-best.

However, such a pessimism is due to the presumption that the government has the burden to overcome the asymmetric information problem. Incentive mechanism design, or more generally screening, is the standard approach in regulation theory to handle regulator's informational disadvantage. Then it seems inevitable for the government to give up some rent, therefore some social welfare, to induce right incentive from the regulated firms.

The question is why does not the government let informed party, the regulated firm, signal first? The key difference between the incentive mechanism design approach and the market signaling approach is who takes the burden to solve the asymmetric information problem. In signaling, the informed party, the regulated firm for example, makes costly expenditure to identify (or to mis-identify) its own type, while it is the uninformed party, the benevolent regulator, who incurs costs to solve the informational problem in screening.

Then it is clear that if the signal by the regulated firm is a donation to the whole society, the government regulation will do better under incomplete information than under complete information through signaling rather than screening. More specifically, we can expect such a result if price is the signaling device and the firm has an incentive to send a low price signal against a regulation. This is the motivation of the paper.

In this paper, in a simple model à la Milgrom and Roberts, we will show that

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3) In the pooling equilibrium, the social welfare can also be higher under asymmetric information since the less efficient incumbent type would produce more than its monopoly level to mimic low cost type. However, in this case, since entry, which would have occurred under full information, is limited, we have to compare welfare increment due to low pre-entry price and welfare loss due to less competition in the future.

4) See Baron(1989), Baron and Myerson(1982), Laffont(1994), and Laffont and Tirole(1986, 1993) for optimal incentive monopoly regulation under asymmetric information.

the performance of entry regulation can be even better under asymmetric information than under complete information. The entry, which incurs some fixed cost, will be socially desirable if the incumbent firm is inefficient, and it will be socially wasteful if the incumbent is efficient.[5] Therefore, to induce entry regulation, the low cost type incumbent will choose a lower price than the monopoly level to signal itself against the high cost type (*separating equilibrium*). The low price by the incumbent monopolist is the donation to the whole society because one-dollar loss in firm's profit due to the lowered price brings more than one-dollar benefit to the consumer surplus. The incentive of the high cost incumbent to mimic low cost type can also be welfare increasing by the same logic (*pooling equilibrium*).

The structure of the paper is as follows. Section 2 explains further why signaling is more appropriate than screening for entry regulation, while the latter fits better for price regulation, under asymmetric information, and based on such a justification, Section 3 describes a simple signaling model of an entry regulation under asymmetric information. Section 4 describes the sequential equilibrium of the signaling game, and Section 5 compares the performance of the entry regulation under asymmetric information with that under full information, and shows that the former is better than the latter. Section 6 concludes the paper with some remarks.

2. Screening vs Signaling in Entry Regulation.

Consider a monopoly market with a potential entrant. Assume no behavioral regulation by the government, and furthermore assume that post-entry duopoly profit is greater than the entry cost so that the potential entrant wants to enter the market. The fact that entry is profitable to the entrant, however, doesn't always imply that the social welfare also increases with entry. The possibility of excess entry requires the benevolent government to implement an entry regulation to prevent a market failure, that is, excess entry.

To make the story simple and to concentrate on the entry regulation under incomplete information, we further assume that there is no strategic link between pre-entry and post-entry market demands. In such a case, if information is complete, it is clear that excess entry can be easily prevented by the government.

What if information is incomplete? Assume that the incumbent's cost is private information, while that of the new entrant is public information. Since excess entry,

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5) The possibility that free market generates too many firms is known as the excess entry theorem. See Mankiw and Whinston(1986), Perry(1984), and Suzumura and Kiyono(1997) for the excess entry theorem as the logical basis of an entry regulation,

and so the government's entry regulation depend on incumbent's cost, the incumbent now has an incentive to take advantage of its private information against the government. This is a typical situation of asymmetric information in government regulation. How can the government optimize under informational disadvantage in designing an entry regulation?

In case of price regulation, incentive mechanism design based on revelation principle is a well-known standard technique for an optimal regulation under asymmetric information. However, such an approach seems unworkable in our entry regulation model. We can think of two reasons for such a conjecture. First, in case of entry regulation, the underlying profit function of the regulated firm is not continuous so that the standard technique of the incentive compatible mechanism is hard to be applied. The discontinuity of the profit function is surely due to the binary nature of the entry decision, contrary to the continuous nature of the price decision.

Second, more fundamentally, the incentive compatibility of an entry regulation cannot be compatible with the optimality of the regulation. In our model where incumbent's cost and entrant's cost are mutually independent, entry is socially undesirable when the incumbent is efficient, that is of low cost. Therefore the natural incentive of the incumbent is to under-report its cost to induce entry regulation. Given such an incentive structure of the incumbent firm, to provide the truth-telling incentive, the government should impose some penalty on the low reports, where the penality is simply allowing entry. However, it is clear that penalizing the low cost incumbent firm for the incentive compatibility, that is allowing entry in case of low incumbent's cost, conflicts with the optimality of an entry regulation.[6)]

While screening through incentive mechanism may be either infeasible or undesirable, market signaling by the incumbent firm can be the solution to the optimal entry regulation under asymmetric information. If the government doesn't do any effort against asymmetric information, the incumbent will do. Since there exist bilateral externalities between low and high cost incumbents, the low cost type will try to signal itself against high cost type, while the latter wants to mimic the former.

The incumbent's price in the pre-entry period is a signal about the production cost, which is the key to the government decision on entry regulation. Under entry regulation, the regulated firm has an incentive to choose a low price to signal himself as an efficient firm and so to deter entry. Thus, contrary to the case of screening, the firm's incentive is consistent with the regulator's objective of maximizing social welfare.[7)] This is why we adopt an signaling model rather than an incentive

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6) In case of price regulation, the regulated firm's incentive is over-reporting. Penalizing high cost and rewarding low cost is consistent not only with the incentive compatibility but also with the optimality of the price regulation.

mechanism design for the entry regulation under incomplete information in this paper.

3. A Simple Signaling Model.

Consider a two-stage three-person entry game in <Figure 1>.[8] In the beginning of the game, Nature N selects firm 1's type, the constant marginal cost c_1, which is either 0 or 2 with equal probability. Firm 1 knows its own cost, however, a potential entrant and the government only knows the probability distribution.

At t_1, firm 1 is the monopolist and chooses a price p^M, which may be different from the monopoly profit maximizing price p^{M*} for the strategic entry deterrence. At t_2, firm 2 makes a decision on entry. If firm 2 decides to enter (IN), the benevolent government G implements an entry regulation and either allows (Y) or regulates (N) firm 2's entry. If firm 2 does not enter (OUT) or the government regulates firm 2's entry, then firm 1 maintains its monopoly position and chooses p^{M*} because there is no further strategic reason to choose other price than the static optimal monopoly price. If firm 2's entry is allowed by the government, then firm 1 and firm 2 play a Cournot competition game.

Firm 2's unit cost is 2, which is known to the other players, firm 1 and the government, and the entry cost F of firm 2 is assumed to be 3.[9] Finally, we assume the same inverse demand function in both periods such as $p=10-X$, where p is the market price and X is the total production level.[10]

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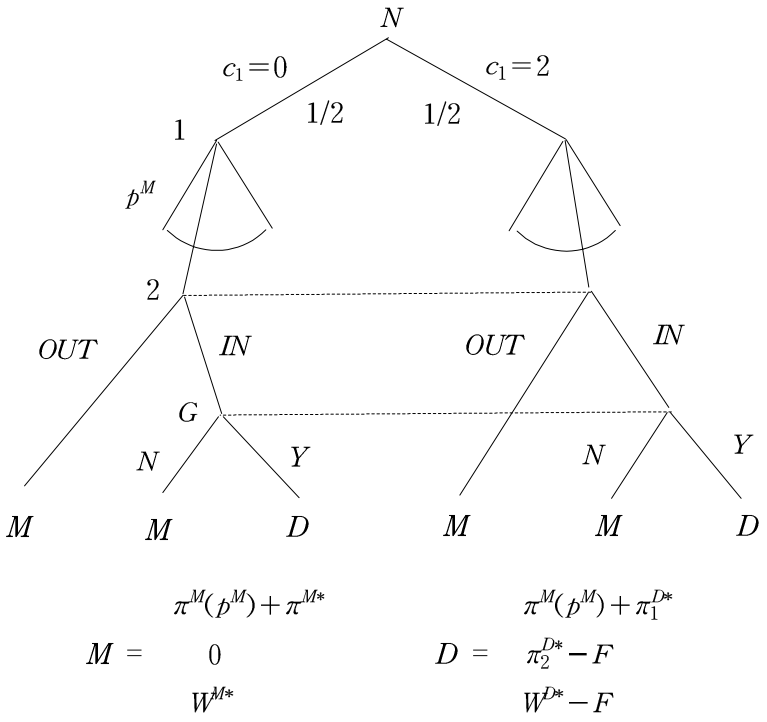
7) We can assume that both incumbent's and entrant's costs are private information. If two costs are positively correlated, the incumbent would choose a high price to signal high cost of the new entrant and so to induce the government to regulate excess entry. Since the incumbent's incentive under entry regulation is not consistent with the optimality, signaling will be suboptimal in this case.

8) <Figure 1> is a reduced form such that the second period subgames are simplified by the equilibrium payoffs in each subgame.

9) These assumptions about firm 2's unit cost and entry cost are not restrictive. Our analysis does not change at all as long as F is less than firm 2's duopoly profit.

10) This is to avoid the complicated issue of strategic entry deterrence. When pre-entry and post-entry demands are interrelated, then the incumbent can deter entry by itself or strategically inducing entry regulation. See Kim(1997, 2000) for the latter issue.

<Figure 1> Entry regulation under incomplete information



In <Figure 1>, payoffs of the firm 1, firm 2, and the government are represented both in the monopoly subgame M and in the duopoly subgame D in this sequence. Firm 1's payoff is the two-period total profit, which is equal to $\pi^M(p^M)+\pi^{M*}$ in case of no entry and equal to $\pi^M(p^M)+\pi_1^{D*}$ in case of entry. Firm 2's payoff is the Cournot Nash equilibrium profit net of entry cost in case of entry, and 0 in case of no entry. Finally, the payoff of the government is the second period social welfare, which is the sum of consumer surplus and profits, net of entry cost in case of entry.

<Table 1> summarizes market outcomes for both periods depending on the market structure. Under monopoly, at t_1 as well as at t_2 in case of no entry, $\pi^M(p^M \mid c_1)$ is the monopoly firm's profit with unit cost c_1 when it chooses p^M, and $W^M(p^M \mid c_1)$ is the social welfare of the monopoly market measured at price p^M. Meanwhile, π^{M*} and W^{M*} are the monopoly profit and social welfare of the monopoly market respectively both measured by p^{M*}. Finally, the market outcomes of the duopoly in t_2 with entry are all measured by the Cournot-Nash equilibrium price.

<Table 1> Market outcomes under monopoly and under duopoly

Monopoly (t_1, t_2) :

$\pi^M(p^M \mid c_1) = (p^M - c_1)(10 - p^M)$

$W^M(p^M \mid c_1) = \pi^M(p^M \mid c_1) + CS^M(p^M \mid c_1) = (p^M - c_1)(10 - p^M) + (10 - p^M)^2/2$

$p^{M*}(c_1) = (10 + c_1)/2$

$\pi^{M*}(c_1) = (10 - c_1)^2/4$

$W^{M*}(c_1) = 3(10 - c_1)^2/8$

Duopoly (t_2) :

$p^{D*}(c_1) = (12 + c_1)/3$

$\pi_1^{D*}(c_1) = (12 - 2c_1)^2/9$

$\pi_2^{D*}(c_1) = (6 + c_1)^2/9$

$W^{D*}(c_1) = \pi_1^{D*}(c_1) + \pi_2^{D*}(c_1) + CS^{D*}(c_1) = (684 - 108c_1 + 11c_1^2)/18$

Note that firm 2 will always chooses to enter since $\pi_2^{D*}(c_1) > F$ regardless of the true value of c_1.[11] Therefore, the original entry game can be simplified to a two-person game with incomplete information between the incumbent and the government. The incumbent firm's price p^M at t_1 plays the role of signaling about c_1. Firm 1 will choose an optimal p^M which maximizes two period total profit under entry regulation, and the benevolent government implements an optimal entry regulation under asymmetric information, both given firm 2's willingness to enter.

4. Signaling Equilibrium under Entry Regulation.

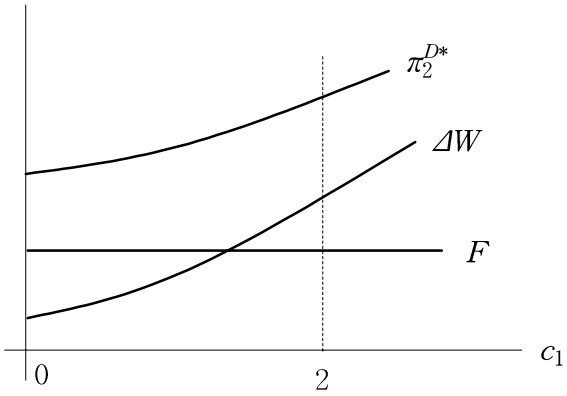
Let $\Delta W(c_1) = W^{D*}(c_1) - W^{M*}(c_1)$ be the welfare increment due to entry at t_2 as a function of c_1. Then the optimal entry regulation will be such as allowing entry if $\Delta W(c_1) \geq F$ and disallowing entry if $\Delta W(c_1) < F$. <Figure 2> describes $\Delta W(c_1)$ in comparison with $\pi_2^{D*}(c_1)$ and F. <Figure 2> shows that firm 2 always wants to enter the market, however, entry is socially desirable when $c_1 = 2$ and it is excessive

11) We intentionally design the model in this way so that we can focus on the performance of the entry regulation under incomplete information. Because there is no strategic links between pre-entry and post-entry market demands, and so the strategic entry deterrence by firm 1 is not feasible, and furthermore because firm 2 always wants to enter regardless of incumbent's type, the market structure at t_2 is solely determined by the government's entry regulation.

when $c_1=0$. If information is complete, entry regulation improves social welfare by preventing excess entry in case of $c_1=0$. Entry regulation is non-binding, and so neutral, when the incumbent's cost is high, that is, $c_1=2$.

Entry may be socially excessive when the new entry incurs business-stealing effect. The business-stealing effect is represented by $\pi_2^{D*}>\Delta W$ in <Figure 2>, which implies that a new entry is more attractive to the entrant than to the whole society.[12] This is the situation that the new entrant steals some profit from the incumbent, and so the welfare increment due to a new entry is less than the entrant's profit. The business-stealing effect is the key factor which justifies the entry regulation by the benevolent government.

<Figure 2> Business-stealing and entry regulation



If the government has only incomplete information, we need to solve the signaling game to find out an optimal entry regulation. In this section, instead of deriving full set of sequential equilibria of our signaling game with refinements, we propose two meaningful equilibria, a separating equilibrium and a pooling equilibrium, to show that the entry regulation brings a more efficient outcome under asymmetric information than under full information. Let (p^M, B, E) be a sequential equilibrium, where p^M is the incumbent's strategy, B is the government belief about incumbent's type, and E is the government's entry regulation.

Separating equilibrium

Consider a separating equilibrium first. In a separating equilibrium, if it exists, the low cost incumbent would set the price in t_1 low enough to make the high cost unable to mimic. The high cost incumbent will then choose the monopoly price in t_1

12) See Mankiw and Whinston(1986) for the business-stealing effect of an entry.

since it cannot prevent entry in t_2 by mimicking the low cost type. Proposition 1 provides such a separating equilibrium.

Proposition 1. There exists a separating equilibrium such that ($p^M(c_1=0)=3$, $p^M(c_1=2)=6$), *B*: if $p^M \leq 3$ then $c_1=0$, if $p^M>3$ then $c_1=2$, and *E*: disallow entry if $p^M \leq 3$ and allow otherwise.[13]

<Proof> (1) Incumbent's strategy with $c_1=0$: If the incumbent chooses $p^M \leq 3$, then it will choose $p^M=3$ since the monopoly profit in t_1 is increasing with p^M in this range. If $p^M=3$, then entry is regulated in t_2 so that the incumbent's two period total profit is $\pi^M(p^M=3 \mid c_1=0)+\pi^{M*}(c_1=0)=21+25=46$. On the other hand, if it chooses in the range of $p^M>3$, then $p^M=p^{M*}(c_1=0)=5$ is the optimal choice since entry cannot be deterred by choosing any other price than the monopoly level in t_1. With entry in t_2, the incumbent's total profit is $\pi^{M*}(c_1=0)+\pi_1^{D*}(c_1=0)=25+16=41$, which is less than the profit of choosing $p^M=3$. Therefore, $p^M=3$ is the optimal strategy of the low cost type incumbent.

(2) Incumbent's strategy with $c_1=2$: If the incumbent chooses in the range of $p^M \leq 3$, it will choose $p^M=3$. In this case, with no entry in t_2, the incumbent's profit is $\pi^M(p^M=3 \mid c_1=2)+\pi^{M*}(c_1=2)=7+16=23$. If the incumbent chooses in the range of $p^M>3$, it will choose a monopoly price $p^M=p^{M*}(c_1=2)=6$ expecting entry in t_2, and then the two period total profit will be $\pi^{M*}(c_1=2)+\pi^{D*}(c_1=2)=16+\frac{64}{9}=23\frac{1}{9}$, which is larger than with $p^M=3$. Therefore, choosing $p^M=6>3$ and allowing entry is the optimal strategy of the high cost incumbent.

(3) Government strategy: First note that the government's belief is consistent with the incumbent firm's strategy. Since the incumbent's type is revealed through the first period price, it is optimal to disallow entry if $p^M \leq 3$ ($c_1=0$) and allow if $p^M>3$ ($c_1=2$). **Q.E.D.**

Pooling equilibrium

Now consider a pooling equilibrium, where the incentive of the high cost incumbent to mimic the low cost type dominates low cost incumbent's signaling

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13) If we assume that the incumbent's cost is 0 with probability α, and 2 with probability $1-\alpha$, then the separating equilibrium in our analysis holds for $\alpha>26/55$.

incentive. In a pooling equilibrium, the high cost incumbent chooses the monopoly price of the low cost type, and maintains its monopoly position through entry regulation, which would not be possible under full information.

Proposition 2. There exists a pooling equilibrium such that $p^M(c_1=0)=p^M(c_1=2)=5$, *B*: if $p^M \le 5$ then firm 1 is low cost type with probability 1/2 and high cost type with probability 1/2, if $p^M > 5$ then firm 1 is high cost type, *E*: disallow entry if $p^M \le 5$ and allow otherwise.

<Proof> (1) Incumbent's strategy with $c_1=0$: If firm 1 chooses $p^M \le 5$, then there will be no entry in t_2, and so it will be a monopolist in both periods. The optimal choice in t_1 will be the monopoly price $p^M=5$, and then the two period total profit will be $2\pi^{M*}(c_1=0)=25+25=50$. On the other hand, if firm 1 chooses $p^M>5$, then there will be an entry in t_2, and the total profit $\pi^M(p^M>5 \mid c_1=0)+\pi_1^{D*}(c_1=0)$ will be clearly less than $2\pi^{M*}(c_1=0)$. Therefore, $p^M=5$ is the optimal choice of the low cost incumbent.

(2) Incumbent's strategy with $c_1=2$: If the incumbent chooses $p^M \le 5$, then it will choose $p^M=5$ since the monopoly profit in t_1 is increasing in this range. Entry is regulated and so the two period total profit of the high cost incumbent will be $\pi^M(p^M=5 \mid c_1=2)+\pi^{M*}(c_1=2)=15+16=31$. Meanwhile, if it chooses $p^M>5$, then there will be entry in t_2, and so $p^M=6$ is the optimal price in t_1. Then the incumbent's profit will be $\pi^{M*}(c_1=2)+\pi_1^{D*}(c_1=2)=16+\frac{64}{9}=23\frac{1}{9}$, which is less than the profit with $p^M=5$. Therefore, $p^M=5$ is the optimal strategy of the high cost incumbent.

(3) Government strategy: If the government observes a price $p^M \le 5$, then the signal adds no further information to the government. If the government allows entry, the expected social welfare in t_2 net of entry cost will be $EW^{D*}-F=\frac{1}{2}W^{D*}(c_1=0)+\frac{1}{2}W^{D*}(c_1=2)-F=\frac{1}{2}(38+28\frac{4}{9})-3=30\frac{2}{9}$. If it regulates entry, the society doesn't have to pay entry cost, and so the social welfare will be $EW^{*M}=\frac{1}{2}W^{M*}(c_1=0)+\frac{1}{2}W^{M*}(c_1=2)=\frac{1}{2}(37\frac{1}{2}+24)=30\frac{3}{4}$. Since $EW^{D*}-F<EW^{M*}$, regulating entry is the optimal choice of the benevolent government. Next, if the signal is such as $p^M>5$, then the government believes that firm 1 is of high cost, and

then allowing entry is the optimal strategy of the government.

(4) Government's belief: Finally let us check whether the government's belief when it observes the signal of $p^M>5$, which is the out-of-the-equilibrium path, is consistent. This can be confirmed by the fact the low cost incumbent never chooses a higher price than the monopoly price $p^M=5$. If the low cost incumbent cannot reveal his true type, then he will choose the monopoly price $p^M=5$. If the low cost incumbent can signal its true type, the price should be less than 6, which is the monopoly price of the high cost incumbent. However, even in this case, the low cost incumbent will never choose a price higher than the monopoly price level $p^M=5$. If we eliminate dominated strategies from the equilibrium, then $p^M>5$ should be the signal of the high cost incumbent. **Q.E.D.**

5. Efficiency of Entry Regulation under Incomplete Information

Now, let us compare market performances under various conditions. <Table 2> summarizes market outcomes under four different situations; free market without government intervention, entry regulation under full information, separating equilibrium under asymmetric information, and finally pooling equilibrium under asymmetric information. The incumbent's profit and the social welfare are the two period total without discount.[14]

First, compare free market with regulation under full information. As we already confirmed, free market generates excess entry when the incumbent is low cost type, and so the entry regulation improves social welfare by limiting undesirable entry.

Next, compare entry regulation under full information with separating equilibrium outcome. The separating equilibrium in case of high cost is the same as the full information outcome. In a separating equilibrium, the high cost incumbent gives up mimicking the low cost type and chooses the monopoly profit maximizing price at t_1 expecting entry in t_2. The behavior of the high cost incumbent and the market structure in t_2 are the same both under asymmetric information and under full information.

14) If future is discounted, then the equilibrium under asymmetric information becomes more toward that under complete information. This is because if the incumbent doesn't care much about the future profit, then the incentive to signal and/or mimic becomes insignificant.

<Table 2> Comparison of market performances

	price t_1	entry t_2	price t_2	incumbent's total profit	social welfare net of entry cost
free market					
$c_1=0$	5	IN	4	41	$72\frac{1}{2}$
$c_1=2$	6	IN	$\frac{14}{3}$	$23\frac{1}{9}$	$49\frac{4}{9}$
entry regulation with full information					
$c_1=0$	5	OUT	5	50	75
$c_1=2$	6	IN	$\frac{14}{3}$	$23\frac{1}{9}$	$49\frac{4}{9}$
separating equilibrium					
$c_1=0$	3	OUT	5	46	83
$c_1=2$	6	IN	$\frac{14}{3}$	$23\frac{1}{9}$	$49\frac{4}{9}$
pooling equilibrium					
$c_1=0$	5	OUT	5	50	75
$c_1=2$	5	OUT	6	31	$51\frac{1}{2}$

However, the behavior of the low cost incumbent in a separating equilibrium is not the same as under full information. The low cost incumbent chooses a lower price than under full information to distinguish itself from the high cost type and to induce government entry regulation. There is an entry under asymmetric information as under full information, however, it is at the cost of lowering pre-entry price by the incumbent.

The low price in the pre-entry period enhances efficiency without affecting post-entry market performance compared with the case of full information. The lack of full information by the regulator improves the efficiency of the entry regulation by inducing a low price from the low cost incumbent that wants to signal itself against the high cost type. The low price by the incumbent is a donation to the whole society.

Finally, consider a pooling equilibrium. In a pooling equilibrium, it is the high cost incumbent that deviates from its monopoly behavior. The low cost incumbent can obtain the same payoff as under full information by choosing the monopoly price in t_1. However, the high cost incumbent chooses a lower price than the monopoly price to make himself undistinguishable from the low cost type. This is because then the entry can be regulated, which was impossible under full information. The

pre-entry price by the high cost incumbent is lower under incomplete information than under full information.

Of course, such welfare improvement in t_1 is at the cost of disallowed entry in t_2. However, due to the entry cost, the welfare loss due to entry regulation can be less than the welfare gain from the low pre-entry price as in our model. As in the separating equilibrium, the informational disadvantage of the government improves the performance of the entry regulation by inducing the high cost incumbent to change his behavior from the monopoly pricing.[15]

Proposition 3. Signaling under incomplete information can improve the performance of the entry regulation compared with under complete information.

6. Concluding Remarks.

The main proposition of this paper is that, while the lack of full information is a barrier to the optimal price regulation, it can improve the performance of the entry regulation. This result is based on the more fundamental observations; first, price regulation is compatible with an incentive mechanism, and entry regulation is better compatible with signaling mechanism, and second, the party who initiates information transmitting process should sacrifice some benefits, and finally, the signaling cost of choosing a low price by the regulated firm is a donation to the whole society.

Entry and price regulations under incomplete information have fundamental difference in terms of the relationship between regulated firm's incentive and optimality of the regulation. In case of price regulation, since firms would have incentive to over-report costs, penalizing high cost firms is consistent not only with the incentive compatibility but with the optimality of the price regulation. On the other hand, the price regulation seems hard to be implemented through signaling mechanism. Assume that the government chooses a regulated price after observing some behavior, for example the price choice, of the monopoly firm. Optimal price regulation requires price move in the same direction as the cost. However, then, the monopoly firm should have an incentive to report a high price to mimic high cost firm for a less strict price regulation. Price regulation gives wrong incentive to the regulated firm if it is implemented via signaling.

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15) However, the welfare analysis of the pooling equilibrium is not as robust as that of the separating equilibrium. Signaling under asymmetric information always improves the performance of entry regulation in a separating equilibrium, however, it depends on demand function, cost distribution, and/or entry cost in case of pooling equilibrium.

On the other hand, in entry regulation, screening may not be compatible with the incentive compatibility and with the optimality conditions simultaneously. If only the incumbent's cost is unknown as in our model, entry tends to be excessive with low incumbent cost. Therefore, to induce entry regulation, the incumbent will always have an incentive to convince the regulator of its low cost. Since incumbent's incentive is naturally welfare increasing, penalty and reward mechanism to induce proper incentive from the informed party is not only unnecessary but actually harmful. Self-signaling will be better for the efficiency of government regulation in this case.

In signaling, the regulated firm, who has the private information, has the burden of proof of its identity. In this case, the asymmetric information can improve, not ameliorates, the performance of the government regulation. This is because the regulated firm should deviate from the monopoly behavior to signal itself. The motivation is surely for its own interests, however, it actually works for the whole society, too.

Several issues can be brought up in relation to this paper. First, can we find more realistic cases where incomplete information is not the cause of the market failure but the cause of supra-efficiency? This is equivalent to asking if we can find many interesting situations under which the signaling costs can be donations to the whole economy.

Second, what's the optimal regulation if both entry and price regulations are implemented at the same time? The government might not be able to implement different mechanisms simultaneously, that is, incentive mechanism for price regulation and signaling mechanism for entry regulation. The incentive price regulation may not be incentive compatible any more if the regulated firm takes entry regulation into consideration at the same time. Likewise, the signaling effect in entry regulation may change against price regulation.

Finally, one clear concluding remark is that we need to understand more about the structural regulation, or simply the entry regulation, to restore balance in regulation theories between behavioral and structural regulations An integrated analysis for the government regulation, which includes both monopoly regulation against the incumbent and entry regulation against potential entrants, is needed.

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