ENTRY POLICY AND ENTRY SUBSIDIES

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Abstract: This paper provides a theory that explains why governments allow free entry and selectively promote entry under certain conditions and deter entry under other conditions. The analysis also identifies conditions under which optimal policy requires that large-scale entry is freely permitted and small-scale entry is deterred. In our model, policymakers use entry policy to strategically shift rents away from foreign producers toward domestic producers and consumers.

Since it may be socially beneficial to subsidize entry by both domestic and foreign firms, we explore the optimal means of promoting entry under complete and incomplete information concerning the entrant's marginal and fixed costs. Under complete information, welfare can be maximized by a two-part subsidy mechanism consisting of a per-unit output subsidy in combination with a lump-sum subsidy or tax. Under incomplete information, the policymaker has incentive to treat domestic and foreign entry differently in setting an optimal entry subsidy. With respect to domestic entry, the policymaker can eliminate any potential welfare losses due to incomplete information if the entrant can be induced to act as a Stackelberg leader. Otherwise, the policymaker may undersubsidize domestic entrants with high marginal costs and oversubsidize entrants with low marginal costs. In the case of foreign entry, the presence of incomplete information implies that entry is undersubsidized.

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1. Introduction

In recent years, the strategic trade policy literature has provided a cogent explanation for policymakers' use of various trade policy instruments, such as subsidies, tariffs, and quantitative restrictions.[1] Absent from this literature, however, has been an explanation of policies that either encourage or deter entry. Policies that encourage entry are selectively applied, such as when governments provide loan guarantees, equity partnerships, and capital subsidies to specific firms in order to induce them into the market. Incumbent firms, by virtue of their presence in the market, do not obtain these subsidies. Entry subsidies are attractive policies because they are potentially less costly to the government than general industry subsidies, which is a particularly important consideration for policymakers facing tight budget constraints. In general, these subsidies may be a viable second-best option when budgetary and institutional constraints preclude the use of other trade policies.

Entry-promoting and entry-deterring policies are both prevalent and substantial on a global scale. The Korean government's subsidy package to steel producer, Posco (Pohang Iron and Steel Company), and the European Community's support of the aerospace manufacturing consortium, Airbus, are two prominent examples of entry promotion.[2] Besides the conventional forms of entry subsidies (*e.g.*, loan guarantees, equity infusions and preferential tax treatment), both cases illustrate the role of nontraditional subsidies intended to induce entry and influence the entrant's output choice. The Korean government targeted Posco as the sole company to receive subsidies for the construction of an integrated steel mill at Kwangyang Bay. Besides providing the mill site and securing financial assistance for the construction

[1] Among others, see Brander and Spencer (1984), Dixit (1984), Krugman (1984), and Eaton and Grossman (1986).

[2] See USITC (1993), Appendix E, for a detailed account of the subsidies granted to foreign steel producers.

of related infrastructure such as road and rail links, port facilities, and a power-generation plant, the Korean government also gave Posco discounts of 20 percent for gas usage, 30 percent for water usage, and 40 percent for usage of rail transportation.[3] Indicative of the broad nature of Airbus' subsidies is the program intended to protect its sales against adverse exchange rate movements. This program alone resulted in payments to Airbus of DM390 million in 1990; however, these payments represent a small portion of the nearly $13.5 billion in government subsidies received by Airbus through 1990.[4] These examples show that entry subsidies may be in the form of output-related payments, such as discounts on input costs and rebates for adverse exchange rate movements, as well as fixed payments.

Of course, not only do governments promote entry under certain circumstances, but they also deter entry through such measures as import licenses, quality standards, and domestic-content requirements. Entry-deterring and entry-promoting measures ultimately alter market structure and the competitive position of specific firms in the market; thus, these measures may be a prime vehicle for implementing so-called industrial policy.

This paper provides a theory to explain why governments have varying policies toward entry and why entry policy differs across sectors. Prior to this paper, little attention has been paid to the strategic aspects of directly managing competition in a market where both domestic and foreign firms compete.[5] Dixit (1984) assessed the welfare impact of mergers, and the associated implications for antitrust policy, by examining exogenous changes in the number of domestic and foreign firms in an oligopoly model where all producers in a given country were identical. He drew explicit conclusions only for cases with restricted demand and cost assumptions.

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[3] For detail, see Amsden (1989), pp. 292 and 297, and USITC (1993), p. E-7.

[4] See USITC (1991), pp. 102-103.

[5] The international trade literature has considered how free entry affects the welfare impact of various trade policies (see Venables, 1985 and Horstmann and Markusen, 1986). Using a comparative-static approach, these papers analyze the effects of trade policies in an equilibrium with free entry.

By contrast, our paper is directed specifically toward entry policy. We derive conclusions under limited cost and demand restrictions in a model where firms are typically heterogeneous. Using a Cournot oligopoly model, we show that entry brings benefits to domestic consumers and losses to incumbent domestic producers. The relative strength of these two effects, which is crucial to the formation of optimal entry policy, depends on the market shares of domestic incumbents and cost and demand conditions. Consequently, the optimal entry policy derives from the composition of domestic firms in the market, and it evolves as that composition changes.

We identify conditions where the policy prescription is to unambiguously allow free entry or unambiguously deter foreign entry regardless of the entrant's size. Yet other conditions are identified where the optimal policy rests on the entrant's output level, implying that large entrants are favored over small entrants. Thus, the policymaker's decision whether to permit entry requires an assessment of the entrant's likely output, or more specifically, the entrant's costs.

Since welfare can be improved in certain cases by encouraging domestic or foreign entry that is privately unprofitable, we also explore the nature of the optimal entry subsidy. This analysis reveals that, under complete information concerning the entrant's costs, welfare can attain its maximum level through the use of a two-part subsidy consisting of a per-unit output subsidy and a lump-sum subsidy or tax.

Given that the magnitude of the optimal entry subsidy and the entrant's optimal output varies with the entrant's costs, a policymaker with incomplete information concerning the entrant's marginal and fixed costs must devise a subsidy mechanism that provides incentive for the entrant to choose the welfare-maximizing subsidy and output combination for its cost type. If the entrant continues to act as a Cournot player, this *incentive-compatibility* constraint cannot be satisfied without sustaining welfare losses in comparison to the complete-information case. With an entry subsidy directed toward domestic firms, the policymaker may *under*subsidize entrants with high marginal costs (*i.e.*, forestalling entry that raises social welfare) and *over*subsidize entrants with low marginal costs (*i.e.*, allowing entry that lowers social welfare). However, the policymaker can achieve the same welfare level as in the complete-information case if the policymaker can induce the domestic entrant to act as a Stackelberg leader. We thus provide a rationale for why policymakers should contract with potential entrants to extract output commitments in return for specified subsidy payments.

In subsidizing entry by foreign firms, the presence of incomplete cost information implies that the policymaker may pay the entrant more than is needed to induce entry. Since this overpayment would result in reduced welfare, the policymaker's response is to not adequately subsidize certain welfare-improving entry. Our examination of entry subsidies considers the differences in applying subsidies to domestic and foreign firms and focuses on the role of fixed costs in determining the optimal subsidy.

The paper is organized as follows. Section 2 develops the model. Section 3 considers the welfare effects of entry; the analysis highlights how optimal entry policy is affected by the market shares of domestic incumbents and the entrant's costs. Section 4 examines optimal entry subsidies under complete and incomplete information concerning the entrant's costs. Section 5 offers concluding remarks.

2. The Model

Our model distinguishes between domestic and foreign firms. The distinction between *domestic* and *foreign* firms depends solely on the location of those individuals that have claim to the firm's profit stream. If we assume that only the capital owners receive any rents (*i.e.*, all other productive factors receive a payment equal to that factor's opportunity cost[6]), then it is immaterial whether the productive resources of *foreign* firms reside in the *foreign* country, the *home* country, or elsewhere. Thus, our model can represent foreign entry into the home country's market through either direct investment or exports.

[6] It is also assumed that a given factor's opportunity cost is unaffected by changes in industry output.

We consider entry into a Cournot oligopoly where n domestic firms and n^* foreign firms produce perfect substitutes. Demand is represented by $p(X)$, where $p_X < 0$. Total market output, X, equals the sum of the individual firm outputs -- that is, $X = \sum_{i=1}^{n} x_i + \sum_{i^*=1}^{n^*} x_{i^*} + x_e$, where x denotes a given firm's output, i denotes an incumbent domestic firm, i^* denotes an incumbent foreign firm, and e denotes the entrant.

Profits for firm k $(k = i, i^*, e)$ are expressed as

$$\pi^k = p(X)x_k - c^k(x_k) - f_k, \tag{1}$$

where $c^k(x_k)$ is the production cost function and f_k is fixed cost.

The first-order condition for firm k's optimal output choice is as follows:

$$\pi^k_x = p(X) + p_X(X)x_k - c^k_x(x_k) = 0. \tag{2}$$

Under appropriate assumptions, a Cournot-Nash equilibrium is defined by the simultaneous solution of equation (2) for all k. To ensure the uniqueness and stability of this equilibrium, we assume that each firm's marginal revenue is everywhere declining with respect to rival output, and that marginal costs are not rapidly decreasing.[7] Specifically, we assume that

$$p_X + p_{XX}x_k < 0 \; \forall \; k \tag{A1}$$

$$c^k_{xx}(x_k) > p_X \; \forall \; k. \tag{A2}$$

Equations (A1) and (A2) are common assumptions. In particular, equation (A1) implies that a given firm reduces output when a rival firm increases output.

Totally differentiating (2), we obtain the following:

$$(p_X + p_{XX}x_k)dX + (p_X - c^k_{xx})dx_k = 0. \tag{3}$$

[7] See Hahn (1962), Rosen (1965), and Al-Nowaihi and Levine (1985).

Based on **(A1)** and **(A2)**, it then follows that

$$dx_k/dX = -\theta_k, \text{ where } \theta_k \equiv [(p_X + p_{XX}x_k)/(p_X - c^k_{xx})] > 0. \tag{4}$$

Thus, θ_k represents the reduction in firm k's equilibrium output that occurs whenever total market output increases by one unit in equilibrium. This term is fundamental to the following welfare analysis.[8]

It is useful for purposes of welfare analysis to treat the entrant's output exogenously and examine the resulting Cournot-Nash equilibrium among the incumbent domestic and foreign firms. In this case, we use the function, $X(x_e)$, to describe the relationship between the entrant's output and the market's equilibrium output. Our stability conditions ensure that $dX/dx_e > 0$.

Furthermore, equation **(2)** describes a functional relationship between an incumbent firm's equilibrium output and the market's output. For firm k, we denote this relationship by $x_k(X)$, and the behavior of dx_k/dX is described by equation **(4)**. Based on the previous discussion, we can express the functional relationship between firm k's equilibrium output and the entrant's output as $x_k(X(x_e))$ (where $dx_k/dx_e = (\partial x_k/\partial X)(dX/dx_e) = -\theta_k(dX/dx_e)$). Inserting this expression into equation **(1)**, firm k's equilibrium profits become a function of the market's equilibrium output $X(x_e)$, which, in turn, depends on the entrant's output level:

$$\pi^k(X(x_e)) = p(X(x_e))x_k(X(x_e)) - c^k(x_k(X(x_e))) - f_k. \tag{1'}$$

The above expression is important to the following welfare analysis, which considers the effect of entry on the equilibrium profits of incumbent firms.

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[8] Farrell and Shapiro (1990) use a similar derivation to analyze mergers in a market containing exclusively domestic firms.

3. Welfare Analysis and Policy Implications

3.1 External Benefits of Entry

From the standpoint of the home country, the welfare effects of entry depend largely on entry's impact on domestic consumer surplus and the producer surplus of domestic incumbents. These sources of surplus are expressed below:

$$E(x_e) = \int_0^{X(x_e)} p(z)dz - pX(x_e) + \sum_{i=1}^{n} \pi^i(X(x_e)) \tag{5}$$

In equation (5), consumer surplus is expressed by the first two terms on the right-hand side, while the producer surplus of domestic incumbents is expressed by the third term. In deciding whether to enter, a given firm ignores the effect of its entry on the above sources of surplus. These welfare effects, while critical in determining the social value of entry, are *external* to the firm's private entry decision.

Based on the above analysis, the *external* benefits of entry (*i.e.*, $B(x_e^f)$) are represented by the change in equation (5) as the entrant's output increases from zero to its equilibrium level. We express these benefits as

$$B(x_e^f) \equiv E(x_e^f) - E(0) = \int_0^{x_e^f} E_x(x_e)\, dx_e \tag{6}$$

where x_e^f is the entrant's equilibrium output level. Due to technological limitations, we assume that there is a maximum (equilibrium) scale of entry, x_e^m, that any firm in the set of potential entrants is unable to exceed. For any potential entrant, it holds that $x_e^f \leq x_e^m$.[9]

It is important to consider the external benefits of entry because general policy recommendations are based on these benefits. For example, if we can show that the external benefits of entry are positive

[9] One might view this restriction in the following fashion. There is a family of cost functions that describe the technology used by any potential entrant, and the set of potential entrants can be described based on their distribution over this family of functions. Assuming that profit functions are well-behaved, there is a mapping between an individual cost function and the entrant's output in a Cournot-Nash equilibrium. Thus, the distribution over the family of cost functions is equivalent to a distribution over various equilibrium outputs, where the support of this distribution reaches the maximum value, x_e^m, known as the *maximum scale of entry*.

for all feasible levels of the entrant's output, then privately profitable entry is *always* socially beneficial. Consequently, free entry is the optimal policy. The next section illustrates this reasoning.

3.2 *Welfare Analysis of Entry*

When the entrant is a *foreign* firm, the welfare effects of entry for the home country, $W(x_e^f)$, are completely captured by $B(x_e^f)$ -- that is, $W(x_e^f) = B(x_e^f)$. When the entrant is a *domestic* firm, the home country's welfare function also includes the entrant's profits, implying that $W(x_e^f) = B(x_e^f) + \pi^e(x_e^f)$.

Let $B(x_e^f) \geq 0$ for $0 < x_e^f \leq x_e^m$. In this case, it follows that privately profitable foreign or domestic entry necessarily raises social welfare. Thus, the home country's optimal policy is to allow free entry, and also to promote privately *un*profitable domestic or foreign entry whenever $B(x_e^f) > -\pi^e(x_e^f)$.

Now, let $B(x_e^f) \leq 0$ for $0 < x_e^f \leq x_e^m$. In this case, foreign entry into the home country's market should be deterred entirely, and domestic entry should be deterred unless the domestic entrant has relatively high profits (*i.e.*, unless $\pi^e(x_e^f) > -B(x_e^f)$). The optimal entry policy toward domestic firms is therefore *selective*, only allowing entry by relatively efficient (*i.e.*, low-cost) competitors.[10]

In all other cases, $B(x_e^f)$ is either positive or negative depending on the entrant's output level, x_e^f. Privately profitable entry is socially beneficial in some cases, but not in others. Thus, entry is permitted (and possibly promoted) or deterred depending on the entrant's likely output level. We summarize below:

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[10] In a pure export market, the home country's welfare benefits are based solely on the producer surplus earned by domestic firms in that market. Accordingly, the *external benefits* from entry (*i.e.*, $B(x_e^f)$) are represented solely by entry's impact on the profits of domestic incumbents. Since entry lowers the profits of existing domestic producers, the external benefits of entry are negative for all levels of the entrant's output (or zero if there are no domestic incumbents). Consequently, $B(x_e^f) \leq 0$ for $0 < x_e^f \leq x_e^m$, implying that domestic entry should be deterred except when $\pi^e(x_e^f) > -B(x_e^f)$ (see Lemma 1). Thus, *selective entry deterrence is always the optimal policy in a pure export market.* This result may explain government attempts to restrain entry or form coalitions of producers in export-oriented markets. There are many examples of this behavior (*e.g.*, DeBeers, OPEC).

Lemma 1. ***The home country's optimal policy toward entry is:***

- ***(a)*** ***free entry (and selective promotion of both foreign and domestic entry) if*** $B(x_e^f) \geq 0$ ***for*** $0 < x_e^f \leq x_e^m$;
- ***(b)*** ***complete deterrence of foreign entry and selective deterrence of domestic entry if*** $B(x_e^f) \leq 0$ ***for*** $0 < x_e^f \leq x_e^m$;
- ***(c)*** ***deterrence or allowance (and possible promotion) of entry depending on the entrant's output level.***

Lemma 1 can be expressed alternatively as follows: *The home country's optimal policy is free entry if condition* ***(a)*** *is satisfied. Otherwise, optimal policy requires some form of entry deterrence.*

Conditions ***(a)*** or ***(b)*** in Lemma 1 may not be difficult to satisfy. For example, if $E_x(x_e) > 0$ for $0 \leq x_e \leq x_e^m$, then condition ***(a)*** is satisfied (because, from equation **(6)**, $B(x_e^f) \geq 0$ for $0 < x_e^f \leq x_e^m$). Consequently, the optimal policy toward entry depends on the behavior of $E_x(x_e)$.

Differentiating E with respect to x_e (see equation **(5)**), we obtain:

$$E_x(x_e) = -p_X X(dX/dx_e) + \sum_{i=1}^{n} d\pi^i/dx_e. \tag{7}$$

We obtain an expression for $d\pi^i/dx_e$ by differentiating equation **(1')**:[11]

$$\begin{aligned} d\pi^i/dx_e &= (p-c^i)(\partial x_i/\partial X)(dX/dx_e) + p_X x_i(dX/dx_e), \\ &= p_X x_i(1 + \theta_i)(dX/dx_e). \end{aligned} \tag{8}$$

Substituting equation **(8)** into equation **(7)**, it follows that

$$E_x(x_e) = -p_X X(dX/dx_e)[1 - \sum_{i=1}^{n} s_i(x_e)(1 + \theta_i)], \tag{9}$$

[11] Since we are examining the *equilibrium* behavior of the incumbent firms, it necessarily holds that $p-c^i_x = -p_X x_i$ (see equation **(2)**) and that $\partial x_i/\partial X = -\theta_i$. (see equation **(4)**). These results are used to derive the second equality in equation **(8)**.

where $s_i(x_e)$ is firm i's market share (*i.e.*, $s_i(x_e) = x_i(X(x_e))/X(x_e)$). Depending on cost and demand conditions, θ_i may be either a constant or a function of x_e.

Referring to equation (9), we define the function, $I(x_e) = [1 - \sum_{i=1}^{n} s_i(x_e)(1 + \theta_i(x_e))]$. Note that $E_x(x_e) = -p_X X(dX/dx_e)I(x_e)$, where $-p_X X(dX/dx_e) > 0$. Thus, $E_x(x_e)$ bears the same sign as $I(x_e)$.

Since $s_i(x_e)$ is monotonically decreasing, we might expect that $I(x_e)$ would be monotonically *increasing* in many instances.[12] Although we make this assumption in the following analysis, our discussion also considers how our results are changed if $I(x_e)$ is instead monotonically *decreasing*.

Let $I(0) \geq 0$. Based on our assumption that $I(x_e)$ increases monotonically, it then follows that $I(x_e) > 0$ for $0 < x_e \leq x_e^m$. Hence, $E_x(x_e) > 0$ for $0 < x_e \leq x_e^m$. Condition *(a)* in Lemma 1 is therefore satisfied (because, from equation (6), $B(x_e^f) > 0$ for $0 < x_e^f \leq x_e^m$).

Note that $I(0)$ is merely the value of I under existing market conditions (*i.e.*, prior to entry). Given that $I(0) \geq 0$ if $\sum_{i=1}^{n} s_i(1 + \theta_i) \leq 1$ under existing conditions (where s_i denotes firm i's market share), the above discussion leads to the following conclusion:

Proposition 1. ***Free entry (and selective promotion of entry) is optimal if and only if*** $\sum_{i=1}^{n} s_i(1 + \theta_i) \leq 1$ ***under existing conditions. Otherwise, some form of entry deterrence is optimal.***

Next, let $I(x_e^m) \leq 0$. Based on our monotonicity assumption, it follows that $I(x_e) < 0$ for $0 < x_e < x_e^m$. Hence, $E_x(x_e) < 0$ for $0 < x_e < x_e^m$. Condition *(b)* in Lemma 1 is thus satisfied (because $B(x_e^f) < 0$ for $0 < x_e^f \leq x_e^m$).

Given that $I(x_e^m) \leq 0$ if $\sum_{i=1}^{n} s_i(1 + \theta_i) \geq 1$ at the maximum scale of entry, the above

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[12] When marginal costs are constant, this condition holds except when p_{XXX} assumes large negative values. Thus, $I(x_e)$ is always increasing under constant marginal costs and a linear or quadratic demand function. When marginal costs increase or decrease linearly, this condition is satisfied unless $p_{XX}c^i_{xx}$ or p_{XXX} assume large negative values (*i.e.*, large relative to the magnitude of $(p_X + p_{XX}x_i)^2$ and $(p_{XX}x_i)^2$). Finally, this condition is less likely to hold if marginal costs increase at a rapidly increasing rate.

discussion leads to the following conclusion:

Proposition 2. ***Complete deterrence of foreign entry (and selective deterrence of domestic entry) is optimal if*** $\sum_{i=1}^{n} s_i(1 + \theta_i) \geq 1$ ***at the maximum scale of entry.***[13]

To complete our analysis, another possibility needs to be addressed, *i.e.*, $I(0) < 0 < I(x_e^m)$. Since $I(x_e)$ is assumed to be monotonically increasing, there exists $I(x_e') = 0$, where $0 < x_e' < x_e^m$. Moreover, $I(x_e) <(>) 0$ for $x_e <(>) x_e'$, which implies that $E_x(x_e) <(>) 0$ for $x_e <(>) x_e'$. The external benefits from entry, *i.e.*, $B(x_e^f) = \int_0^{x_e^f} E_x(x_e)\, dx_e$, are therefore *negative* and monotonically decreasing for $0 < x_e^f < x_e'$. After reaching a minimum at x_e', $B(x_e')$ is then monotonically increasing for $x_e' < x_e^f < x_e^m$. Consequently, $B(x_e')$ is negative in sign, but $B(x_e^m)$ may assume either positive or negative values.

Based on the above reasoning, if $B(x_e^m) \leq 0$, it follows immediately that $B(x_e^f) \leq 0$ for $0 < x_e^f \leq x_e^m$. In this case, Lemma 1 indicates that optimal policy requires complete deterrence of foreign entry and selective deterrence of domestic entry. However, if $B(x_e^m) > 0$, there exists x_e'', where $x_e' < x_e'' < x_e^m$, such that $B(x_e'') = 0$. Moreover, $B(x_e^f) <(>) 0$ for $x_e^f <(>) x_e''$. The external benefits from entry are *positive* whenever the entrant's output *exceeds* x_e'', implying that free entry should be allowed (and entry should be selectively promoted) at these output levels. However, the external benefits from entry are *negative* when the entrant's output is *below* x_e'', implying that foreign entry should be completely deterred and domestic entry should be selectively deterred at these output levels. In this case, the output threshold, x_e'', separates a free-entry policy from an entry-deterrence policy. We summarize:

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[13] We show in Proposition 3 that this condition, $\sum_{i=1}^{n} s_i(x_e^m)(1 + \theta_i(x_e^m)) \geq 1$ (*i.e.*, $I(x_e^m) \leq 0$), is *sufficient*, but not *necessary*, to ensure that foreign entry should be completely deterred (and domestic entry should be selectively deterred).

Proposition 3. When neither of the conditions in Propositions 1 or 2 hold, the optimal policy is complete deterrence of foreign entry and selective deterrence of domestic entry if $B(x_e^m) \leq 0$. Otherwise, if $B(x_e^m) > 0$, there exists a threshold output level, x_e'', which satisfies $B(x_e'') = 0$. Entry at outputs below this threshold should be completely deterred if the entrant is foreign and selectively deterred if the entrant is domestic. Entry at outputs above this threshold should be freely permitted (and promoted in selective cases) regardless whether the entrant is foreign or domestic.

In contrast to Propositions 1 or 2, which describe conditions where entry should be allowed freely or foreign entry should be deterred completely regardless of the entrant's output choice, Proposition 3 examines a different situation for the policymaker. In this situation, the optimal policy may depend on the entrant's output, with entry being permitted only if the entrant's scale of operations is sufficiently large (*i.e.*, greater than x_e''). Recognizing that the entrant's equilibrium output is related endogenously to the characteristics of its cost function, this implies that the policymaker is actually forced to identify the entrant's costs. In essence, there exists a cost threshold which separates entrants that are allowed free entry from those that are potentially deterred.

For example, assume that the technology used by any potential entrant can be described by a cost function that is a member of a family of functions, $F(\eta)$, where this family consists of the cost functions $c^e(x_e) = g(x_e) + \eta h(x_e)$ for $\eta \in [\eta_{min}, \eta_{max}]$. We also assume that $h_x(x_e) > 0 \; \forall \; x_e$, which implies that the marginal cost of output is increasing in η. Under conditions where individual profit functions are strictly concave, each entrant's equilibrium output, x_e, is uniquely determined by η, and $\partial x^e(\eta)/\partial\eta < 0$. Now, if $B(x_e^m) = B(x^e(\eta_{min})) > 0$, it holds from Proposition 3 that there exists a threshold cost level, η'', where $B(x^e(\eta'')) = 0$. Entry is freely permitted when $\eta < \eta''$, but it may be deterred when $\eta > \eta''$. Note that a family of linear cost functions can be described by $c^e(x_e) = a + \eta x_e$ for $\eta \in [\eta_{min}, \eta_{max}]$, which implies that η'' is actually a marginal-cost threshold. Only relatively efficient entrants (*i.e.*, $\eta \leq \eta''$) are freely allowed into the market. Relatively inefficient *domestic* entrants (*i.e.*, $\eta > \eta''$) are selectively admitted into the market if they generate sufficient profits to compensate for their negative external benefits. Consequently, those domestic entrants with relatively high marginal costs, but relatively low fixed costs, may still gain admittance to the market.

The reasoning behind Proposition 3 is that the market shares of domestic incumbents progressively shrink as the entrant increases in size. At the same time, the home country's welfare benefits from a given increase in the entrant's output typically become larger as the market shares of domestic incumbents shrink. Hence, large-scale (*i.e.*, low-cost) entrants are often capable of providing more welfare benefits than smaller-scale (*i.e.*, higher-cost) entrants.

More formally, entry creates two key effects: (i) a price reduction, and, (ii) an output reduction by domestic incumbents. The price reduction raises consumer surplus but lowers producer surplus; so, the *net* gain in social welfare equals the price change multiplied by the amount by which total domestic sales exceed domestic output (*i.e.*, the term, $-p_X X(dX/dx_e)[1 - \sum_{i=1}^{n} s_i(x_e)]$ in equation (9)). Clearly, the *net* welfare gain from the price reduction becomes larger as the combined market share of domestic incumbents becomes smaller.

The second effect of entry, the reduction in the output of domestic incumbents, causes a loss of producer surplus since price exceeds marginal cost. As expected, this loss frequently becomes smaller as the market share of domestic incumbents declines. This result arises for two reasons. Most simply, it occurs because the total output reduction by domestic incumbents is smaller when there are fewer domestic firms in the market. However, it also holds that a domestic firm's price-cost margin is positively related to its (equilibrium) market share, implying that a domestic firm's output reduction results in a smaller loss of producer surplus when its market share is relatively small (as expressed by the term, $p_X X(dX/dx_e)(\sum_{i=1}^{n} s_i(x_e)\theta_i)$, in equation (9)). Entry is thus more likely to increase welfare when domestic firms occupy a relatively small portion of the market.

Finally, assume that the function, $I(x_e)$, is monotonically *decreasing*. Based on reasoning analogous to that used above, free entry is optimal when the condition identified in Proposition 1 holds at the *maximum scale of entry*. Complete deterrence of foreign entry and selective deterrence of domestic entry is optimal when the condition identified in Proposition 2 holds under *existing conditions*. The results in Proposition 3 are changed, however, so that the proper entry policy is either to allow free entry at all output levels, or to potentially deter *large-scale* entrants while allowing the free entry of *small-scale* entrants. This change occurs because, if $I(x_e)$ decreases monotonically, the reduction in the domestic incumbents' output in response to a marginal increase in the entrant's output becomes significantly larger as the entrant's output increases. This effect swamps the other effects mentioned above, implying that the welfare benefits from entry may eventually decrease as the entrant's output increases.[14]

3.3 Threshold Domestic Market Shares

Based on the prior analysis, the policymaker's decision to permit or deter entry depends largely on the combined market share of domestic firms. The following proposition states this relationship explicitly:

***Proposition 4.* Let $\theta_i = \theta\ \forall\ i$. Define $T \equiv 1/(1 + \theta)$. Free entry (and selective promotion of entry) is optimal if and only if the combined market share of domestic firms is less than or equal to T. Otherwise, some form of entry deterrence is optimal.**[15]

Note that $\theta_i = \theta\ \forall\ i$ when domestic firms are homogeneous or when demand and cost functions are

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[14] It should be noted, though, that $I(x_e)$ is not likely to decrease monotonically unless marginal costs are rapidly increasing or the (inverse) demand curve becomes increasingly concave as output increases (see footnote 12).

[15] The proof follows directly from Proposition 1. If $\theta_i = \theta\ \forall\ i$, then the condition, $\sum_{i=1}^{n} s_i(1 + \theta_i) \leq 1$, implies that $\sum_{i=1}^{n} s_i \leq 1/(1 + \theta)$, where $\sum_{i=1}^{n} s_i$ is merely the combined market share of the domestic firms.

linear.

Under the conditions described above, the market-share threshold T separates a free-entry policy from an entry-deterrence policy. All market shares below T are in the *free-entry* range, while those above T are in the *entry-deterrence* range. For example, $T = 1/2$ when demand is linear and marginal costs are constant, implying that free entry is optimal if and only if the combined market share of domestic firms is less than one half.[16] Otherwise, when the combined market shares of domestic incumbents exceeds one half, some form of entry deterrence is optimal.[17] In examining merger behavior, Dixit (1984) obtains an analogous result under the same cost and demand restrictions, assuming that firms are homogeneous. Here, we find that this particular result extends to a model where firms have varying costs.

As T declines in size, the free-entry range becomes smaller. Given that T and θ are inversely related, the free-entry range becomes smaller as θ increases in size. Note from equation (4) that $\theta_i \equiv [(p_X + p_{XX}x_i)/(p_X - c^i_{xx})]$, where $(p_X + p_{XX}x_i)$ and $(p_X - c^i_{xx})$ are both negative in sign (see (A1) and (A2)). Hence, θ increases (and T decreases) as p_{XX} and c^i_{xx} decline in value. From this, we conclude as follows:

Remark. The range of market shares where free entry (and selective promotion of entry) is the optimal policy shrinks as the demand curve becomes increasingly concave and as domestic incumbents' marginal cost curves decline in slope.

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[16] Based on these cost and demand assumptions (*i.e.*, $p_{XX}, c^i_{xx} = 0$) and the definition of θ_i from equation (4), it holds that $\theta_i = 1 \; \forall \; i$. Consequently, $T \equiv 1/(1+\theta) = 1/2$.

[17] Specifically, if the combined market share of domestic incumbents would still exceed one half at the *maximum scale of entry*, then optimal policy recommends that foreign entry be completely deterred and domestic entry be selectively deterred (see Proposition 2). On the other hand, if this combined market share currently exceeds one half, but would be substantially less than one half at the maximum scale of entry, then optimal policy recommends that large-scale entry be permitted and small-scale entry be completely deterred in the case of a foreign entrant and selectively deterred in the case of a domestic entrant (see Proposition 3).

The above remark is readily explained. When an entrant places output onto the market, domestic incumbents reduce their own output. This output reduction increases in magnitude as the demand curve becomes more concave and as marginal cost curves decline in slope. Consequently, entry induces a greater loss of producer surplus by domestic incumbents. The *external* benefits from entry are thus diminished, implying that there is a smaller range of market shares where free entry is optimal.

The results from this section indicate that the optimal policy toward entry evolves in accordance with dynamic changes in market structure. Starting from a position where no domestic firms serve the market, free entry (and the selective subsidization of both foreign and domestic entry) is the optimal policy.[18] However, as domestic firms obtain an increasing share of the market, the incentives arise for switching to some form of entry deterrence. Eventually, foreign entry may be discouraged entirely (or permitted only in the case of large-scale entry[19]), and relatively inefficient domestic entrants also may be deterred. Conversely, starting from a position where only domestic firms serve the market, the optimal policy is always some form of entry deterrence.

4. Optimal Entry Subsidies Under Complete and Incomplete Information

This section discusses the desirability of subsidizing entry and analyzes the optimal entry subsidy under complete and incomplete information concerning the entrant's costs. Our analysis does not consider whether an entry subsidy is necessarily the best policy for increasing social welfare. Policies such as domestic production subsidies and import tariffs may frequently lead to higher welfare levels than

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[18] Note that when the market is inhabited solely by foreign firms, policymakers should promote domestic entry in order to improve the terms of trade and to transfer rents from foreign firms to domestic firms. Of course, these objectives can also be attained through import tariffs, which would appear consistent with some of the arguments for *infant-industry protection*.

[19] The prospect of *large-scale* foreign entry may arise when a point has been reached where *several* foreign firms wish to enter the market.

can be achieved by subsidizing entry, particularly if entrants incur substantial fixed costs or face higher marginal costs than domestic incumbents. Nonetheless, entry subsidies may represent a viable second-best policy option when subsidies to the domestic industry are precluded by their considerable expense and increases in import tariffs are restricted by institutional barriers (*e.g.*, GATT).

In general, social welfare can be increased by subsidizing privately unprofitable entry whenever $B(x_e^f) > -\pi(x_e^f)$. Theoretically, the home country is indifferent between subsidizing a foreign or domestic entrant under these conditions. The home country can induce entry by giving the entrant a lump-sum payment equal to the private losses from entry, *i.e.*, $-\pi^e(x_e^f)$. This subsidy payment directly decreases social welfare in the case of a foreign entrant. Although this subsidy payment is merely a domestic transfer payment in the case of a domestic entrant, the home country's welfare is nonetheless reduced by the entrant's private losses, $\pi^e(x_e^f)$. However, these losses are less than the external benefits of entry.

Although we have shown that subsidizing entry can raise social welfare, we have not explored the optimal form of the entry subsidy. Since the entrant's output choice determines the social benefits from entry, the policymaker has incentive to influence that choice through the use of output-related subsidies (*e.g.*, unit subsidies, capital subsidies, or input subsidies for utilities or materials costs). However, given that the policymaker must ensure that the entrant earns nonnegative profits, and that the policymaker does not wish to subsidize a foreign entrant beyond the zero profit level, it may be optimal to supplement an output-related subsidy with a lump-sum subsidy or tax.

We now consider the policymaker's welfare-maximization problem in choosing its optimal subsidy. Let s denote a subsidy applied to each unit of output, and l denote a lump-sum subsidy. Letting c denote the entrant's marginal costs prior to subsidization,[20] the entrant's equilibrium output is a function of its marginal costs *net* of the output subsidy, expressed by $x^e(c,s) = x^e(c-s)$, where $dx^e/dc = -dx^e/ds < 0$. Thus, the entrant's output is a decreasing function of its actual marginal costs and an

[20] Purely for expositional convenience, we assume that marginal costs are constant.

increasing function of the output subsidy.

The welfare benefits from entry equal the *external* benefits of entry (*i.e.*, $B(x^e(c,s))$), less the cost of the subsidy (*i.e.*, $sx^e(c,s) + l$), plus the entrant's profits (*i.e.*, $\pi^e(c,s,l)$) if the entrant is a domestic firm. The policymaker sets the subsidy level to maximize welfare subject to the constraint that the entrant's profits are nonnegative,

$$max_{s,l}\ \mathcal{L} = B(x^e(c,s)) - (s(x^e(c,s)) + l) + \gamma\pi^e(c,s,l) + \lambda\pi^e(c,s,l), \tag{10}$$

where $\gamma \equiv 1(0)$ if the entrant is domestic(foreign), λ is the Lagrangean multiplier, and $\pi^e(c,s,l) = (p(X(x^e(c,s))) - c)x^e(c,s) - f_e + (sx^e(c,s) + l)$. Note that $\pi^e(c,s,l)$ represents the entrant's profits *inclusive* of any subsidy payments. Recognizing that $B_x(x^e(c,s)) = E_x(x^e(c,s))$ (see equation (6)), the first order conditions are as follows:

$$\partial\mathcal{L}/\partial l = \gamma + \lambda - 1 = 0, \tag{11a}$$

$$\partial\mathcal{L}/\partial s = [E_x(x^e(c,s)) - s + (\gamma + \lambda)p_X x^e(c,s)(dX_r(x^e(c,s)/dx_e)](dx^e(c,s)/ds)$$
$$+ (\gamma + \lambda - 1)x^e(c,s) = 0, \tag{11b}$$

where $dX_r(x^e(c,s))/dx_e < 0$ represents the total reduction in *rival* output resulting from an increase in the entrant's output.[21] Inserting **(11a)** into **(11b)**, it holds that the optimal output subsidy, s^*, satisfies the

[21] As reflected in equation **(11b)**, the effect of the subsidy on the entrant's profits can be described as follows: $d\pi^e(c,s,l)/ds = x^e(c,s) + [p + p_X x^e(c,s)(dX/dx_e) - (c-s)](dx^e(c,s)/ds)$. Noting that $dX/dx_e \equiv 1 + dX_r/dx_e$, the expression in brackets can be expressed alternatively as $[p + p_X x^e(c,s) - (c-s) + p_X x^e(c,s)(dX_r/dx_e)]$. Since the entrant's first-order condition for profit maximization satisfies $p + p_X x^e(c,s) -(c-s) = 0$, the bracketed expression reduces to $p_X x^e(c,s)(dX_r/dx_e)$, implying that $d\pi^e(c,s,l)/ds = x^e(c,s) + p_X x^e(c,s)(dX_r/dx_e)(dx^e(c,s)/ds)$.

following condition:[22]

$$s^* = E_x(x^e(c,s^*)) + p_Y x^e(c,s^*)(dX_f(x^e(c,s^*))/dx_e) > 0. \tag{12}$$

The right-hand side of the equality contains two terms: the first term represents the external benefits arising from an additional unit of the entrant's output, and the second term represents the increase in the entrant's profits that results from the retrenchment in rival output associated with the entrant's output increase (*i.e.*, similar to the profit-shifting effect identified in Brander and Spencer, 1984).[23] Additions to the entrant's output produce positive external benefits at the margin (whenever $I(x_e)$ is monotonically increasing) and increase the entrant's profits due to rival retrenchment. Thus, it is optimal to impose a positive per-unit output subsidy, allowing that subsidy to increase to the point where the benefits from an additional unit of the entrant's output equal the per-unit subsidy.[24]

Now, consider condition **(11a)**. If the entrant is domestic, then $\gamma = 1$ (by definition). Condition **(11a)** holds only if $\lambda = 0$, implying that the entrant's profit constraint does not affect social welfare. This occurs because any subsidy payment in excess of the amount required to encourage entry is merely a domestic transfer payment from the government to the firm. However, if the entrant is

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[22] We assume that the second-order conditions for an internal maximum are satisfied. Moreover, entry is not permitted unless $B(x_e^f)$ $(= \int_0^{x_e^f} E_x(x_e)\, dx_e) > 0$, where $E_x(x_e) = -p_Y X(dX/dx_e)I(x_e)$. Given that $-p_Y X(dX/dx_e) > 0$, and that $I(x_e)$ is monotonically increasing, this result requires that $I(x_e^f) > 0$, which implies that $E_x(x_e^f) > 0$ (where $x_e^f = x^e(c,s^*)$). Since $p_Y x^e(c,s)(dX_f(x^e(c,s^*))/dx_e) > 0$, it follows that equation **(12)** is positive in sign.

[23] In the case of domestic entry, an increase in the entrant's profits generates direct welfare gains. In the case of foreign entry, this increase in profits lowers the subsidy payment needed to induce entry.

[24] If $I(x_e)$ is instead monotonically decreasing, then it is possible that $I(x^e(c,0)) < 0$, which implies that $E_x(x^e(c,0)) < 0$. In this case, the external benefits of entry decline as output increases above $x^e(c,0)$. If the profit-shifting effect of increasing the entrant's output is relatively small (*i.e.*, $p_Y x^e(c,0)(dX_f(x^e(c,0))/dx_e) < -E_x(x^e(c,0))$, then the optimal entry subsidy requires an output *tax* in combination with a lump-sum subsidy. The total subsidy payment would be positive, however. Under these conditions, optimal policy may require that low marginal-cost entrants incur an output tax, while high marginal-cost entrants receive an output subsidy.

foreign, $\gamma = 0$. Condition (11a) holds only if $\lambda = 1$, implying that the entrant's zero-profit constraint is binding. Since any increase in the subsidy payment transfers income abroad, the home country's subsidy payment should only be sufficient to ensure that the entrant earns zero profits. In fact, a lump-sum *tax* is appropriate when the optimal per-unit output subsidy is large enough to ensure that the foreign entrant earns positive profits.[25]

From the above discussion, it is clear that the structure of a per-unit output subsidy and a lump-sum subsidy is an efficient mechanism for inducing an entrant to choose the welfare-maximizing output level under complete information. It can be shown that other more complicated mechanisms, involving *nonlinear* output subsidies and lump-sum subsidies or taxes, may be used to attain the same welfare level. We conclude as follows:

Proposition 5. With respect to entry subsidies under complete information, social welfare can be maximized through a two-part structure, (s^*, l^*), consisting of a per-unit output subsidy and a lump-sum subsidy or tax. The per-unit subsidy, s^*, is positive and satisfies equation (12). In the case of a foreign(domestic) entrant, the lump-sum subsidy or tax is set to ensure that the entrant's profits are zero(nonnegative).

The above proposition assumes that the policymaker has complete information concerning the entrant's *marginal* and *fixed* costs, so that it can set the optimal output subsidy for the entrant's cost type and exactly calculate the private losses from entry (in the absence of a subsidy). Now suppose that the

[25] In fact, a lump-sum *tax* (in combination with a per-unit output subsidy) is always required when $E_{xx}(x_e) > 0$. Under this condition, the *marginal* external benefits from an additional unit of the entrant's output exceed the *average* external benefits per unit of the entrant's output. Since the result in equation (12) implies that the per-unit output subsidy exceeds the *marginal* external benefits from the entrant's output, it follows that the per-unit output subsidy exceeds the *average* external benefits per unit of the entrant's output. Because optimal policy requires that the *total* subsidy payment be no greater than the *total* external benefits from entry, a lump-sum tax must be imposed to offset the *excessive* payments made through the output subsidy.

policymaker cannot observe the entrant's marginal or fixed costs. Since the decision to enter may depend on the policymaker having previously committed to an entry subsidy, the policymaker must devise an output-based subsidy schedule that separates entrants with differing marginal costs, giving each type of entrant the incentive to choose the output/subsidy combination that corresponds to the policymaker's (constrained) optimum for its type. To further complicate matters, the total subsidy payment should ideally allow the proper amount of entry -- that is, it should induce entry by all firms with private losses (excluding the subsidy) that are less than the external benefits of entry and deter entry by all other firms. In other words, the total payment should not be so small that it discourages welfare-increasing entry by those entrants with relatively low fixed costs, nor so large that it encourages welfare-decreasing entry by those entrants with relatively high fixed costs.

We now examine the optimal entry subsidy mechanism under incomplete information regarding the entrant's marginal and fixed costs, assuming that the subsidy policy applies only to *domestic* entrants.[26] In addition, we continue to assume that the domestic social welfare function assigns equal weight to consumer surplus, producer surplus, and government revenue. These assumptions are important because they imply that there is no social loss if the policymaker *overpays* an entrant (*i.e.*, pays the entrant more than is needed to encourage entry) as long as the entrant's private losses (exclusive of the subsidy) are less than the external benefits of entry. In the case of foreign entry, there is the added complication that overpayments to foreign entrants reduce social welfare. That would also be the case with respect to domestic entry if we assumed instead that there is an additional social cost involved in raising or spending government funds. Later, we discuss the implications of relaxing our assumptions.

By the Revelation Principle (see Myerson, 1979), the policymaker's problem is equivalent to

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[26] We assume that incumbent firms know the entrant's true costs prior to choosing output. Incumbent firms may be better informed than the policymaker concerning the entrant's costs because the policymaker may be forced to commit to an entry policy (*i.e.*, an entry subsidy) long before a specific firm decides to enter the market, and even longer before that entrant reaches the output stage.

setting the welfare-maximizing subsidy that induces the entrant to reveal its true costs. Moreover, rather than solving for the optimal subsidy expressed as a function of output, this problem can be solved instead by maximizing welfare with respect to the *direct revelation* mechanism, $(x^e(c_R), t(c_R))$, where $x^e(c_R)$ and $t(c_R)$ represent, respectively, the entrant's output and total subsidy payment as a function of its reported marginal cost (*i.e.*, c_R).

To induce truthtelling by the entrant, the following incentive-compatibility constraint must be satisfied:

$$\pi(x^e(c), t(c), c) \geq \pi(x^e(c_R), t(c_R), c)) \;\forall\; c_R. \tag{13}$$

If the social welfare and profit functions are well-behaved, then the solution to the welfare-maximization problem is continuous with respect to c. Thus, equation (13) cannot be satisfied locally unless the following condition holds:

$$\pi_x(x^e(c), t(c), c)x^e_c + \pi_t(x^e(c), t(c), c))t_c = 0. \tag{14}$$

Since $\pi(x^e(c), t(c), c) = (p(X(x^e(c))) - c)x^e(c) + t(c)$, it follows that $\pi_t(x^e(c), t(c), c) = 1$ and $\pi_x(x^e(c), t(c), c) = p + p_X x^e(c) - c$ under Cournot behavior. Substituting into equation (14), we obtain:

$$(p + p_X x^e(c) - c)x^e_c(c) + t_c(c) = 0. \tag{15}$$

Under *complete* information, the policymaker acts optimally by subsidizing the entry of any firm with private losses that are less than the external benefits arising from its entry. On the other hand, the policymaker does not subsidize any firm with private losses that are greater than the external benefits of its entry. A policymaker acting under *incomplete information* can achieve an equally efficient outcome only by setting the total subsidy payment equal to the external benefits of entry, *i.e.*, $t(c) = B(x^e(c)) \;\forall\; c$. Differentiating this expression reveals that the optimal amount of entry is allowed when the following condition is satisfied:

$$B_x(x^e(c))x^e_c = E_x(x^e(c))x^e_c = t_c(c). \tag{16}$$

Combining equations (15) and (16), we obtain:

$$E_x(x^e(c)) + p + p_X x^e(c) - c = 0. \tag{17}$$

Equation (17) must hold in order to both satisfy incentive compatibility and permit an optimal amount of entry. Of course, in the complete information case, the entrant's output under Cournot behavior, $x^e(c,s)$, satisfied the first-order condition, $(p + p_X x^e(c,s) - c) + s = 0$. Substituting this expression into the optimal output subsidy expressed by equation (12), it holds that the welfare-maximizing output level for each cost type satisfies the following condition under *complete* information:

$$E_x(x^e(c,s^*)) + (p + p_X x^e(c,s^*) - c) + p_X x^e(c,s^*)(dX_r(x^e(c,s^*))/dx_e) = 0. \tag{18}$$

Equation (18) differs from equation (17) by the presence of the term, $p_X x^e(c,s^*)(dX_r(x^e(c,s^*))/dx_e)$, which captures the effect on the entrant's profits due to the retrenchment of rival output. Of course, this term would be included in equation (15), and consequently in equation (17), if the entrant acted as a Stackelberg leader. By committing to an optimal (output-related) subsidy schedule in advance, and subsequently contracting with any potential entrant so that the entrant commits to a specified output in return for the payment specified by the subsidy schedule, the policymaker may potentially force the entrant to act as a Stackelberg leader. If this behavior arises, and the policymaker uses the output-related subsidy schedule, $t(x^e(c)) = B(x^e(c))$, then the same welfare level is attained as under complete information (because equations (16) and (18) are both satisfied). Thus, the policymaker should extract an output commitment from any potential entrant as a condition for making the subsidy payment.

However, if an entrant continues to act as a Cournot player, the policymaker cannot induce the welfare-maximizing output choice without risking entry by firms with *excessively* high fixed costs.

The entrant will not provide the welfare-maximizing output level under Cournot behavior unless the subsidy for a marginal output increase equals $E_x(x^e(c)) + p_X x^e(c)(dX_r(x^e(c)/dx_e))$, which exceeds the external benefits of that additional output, $E_x(x^e(c))$. Since this relationship must hold with respect to the optimal output choice of each type of entrant, it is clear that the total subsidy payment would eventually exceed the external benefits of entry if the policymaker followed this strategy in determining the entrant's output.[27]

To reduce the potential losses from *excessive* entry, it can be shown that, under an assumption that marginal and fixed costs are uniformly and independently distributed (and that demand is linear), the policymaker *under*subsidizes domestic entrants with relatively *high* marginal costs and *over*subsidizes domestic entrants with relatively *low* marginal costs in comparison to the efficient outcome. *Under*subsidization occurs when firms whose entry would *increase* social welfare are not subsidized sufficiently to enter the market. *Over*subsidization occurs when firms whose entry would *decrease* social welfare are subsidized sufficiently that they enter the market. Under incomplete information (and the previous assumptions), the optimal subsidy policy toward domestic entrants also implies that high

[27] Under Cournot behavior by the entrant, the policymaker wants to induce a domestic entrant to produce additional output in equilibrium so that the entrant realizes the additional profits that result from the associated reduction in rival output. To get the entrant to produce this added output, the policymaker is willing to pay an amount equal to these additional profits, $p_X x^e(c)(dX_r(x^e(c)/dx_e))$, plus an amount equal to the external benefits of the additional output, $E_x(x^e(c))$. Consequently, the policymaker is willing to pay the amount, $E_x(x^e(c)) + p_X x^e(c)(dX_r(x^e(c)/dx_e))$, to induce the entrant to produce another unit of output.

However, once the policymaker has induced the entrant to produce additional output and internalize the additional profits due to rival retrenchment, it would be socially beneficial to have subsidized entry only if the private losses from entry were less than or equal to the external benefits of entry. Consequently, to prevent welfare-reducing entry by firms with excessively high fixed costs, the total subsidy payment should not exceed the external benefits of entry. This implies that the policymaker would like to use an output-based subsidy to encourage additional output by the entrant, but then reduce the total subsidy payment through a lump-sum tax. The efficient outcome is unattainable, though, because setting the optimal subsidy in this manner for each type of entrant would violate incentive compatibility.

If the entrant acts as a Stackelberg player, there is no need to use an output-based subsidy to induce the entrant to internalize the profit benefits resulting from rival retrenchment. Consequently, the efficient outcome is attainable by setting the subsidy equal to the external benefits of entry.

marginal-cost entrants produce more output and low marginal-cost entrants produce less output than in the complete-information case.[28] We now summarize the above discussion:

Proposition 6. ***In setting the optimal entry subsidy for domestic firms, the presence of incomplete cost information leads to lower social welfare in comparison to the complete information case. Under incomplete information, domestic entrants with relatively low marginal costs may be "oversubsidized" (and produce too little output) while those with relatively high marginal costs may be "undersubsidized" (and produce too much output) in comparison to the efficient outcome.***

An exception to this result occurs if the policymaker induces the domestic entrant to make an output commitment, subject to the subsidy schedule $t(x_e) = B(x_e)$, and that commitment induces the entrant to act as a Stackelberg leader. In this case, the same welfare level is attained under incomplete information as in the case of complete information.

With respect to promoting the entry of foreign firms, it can be shown that foreign entry is *under*subsidized under incomplete information relative to the efficient outcome attained under complete

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[28] Proof available from the authors. To satisfy the terminal conditions for an optimal solution, a marginal increase in the subsidy payment to the highest marginal-cost entrant must not affect welfare after considering the impact of that increase on the subsidy payments received by all other entrant types. This result implies that some types of entrants are undersubsidized while others are oversubsidized. Based on the optimality conditions derived from the Hamiltonian, it can be shown that the only feasible solution requires that high marginal-cost entrants are undersubsidized while low marginal-cost entrants are oversubsidized.

If an entrant of a given marginal-cost type is undersubsidized (*i.e.*, $t(c) < B(x^*(c))$), then there is an incentive to stimulate that entrant's output beyond the level that satisfies equation **(18)** in order to induce further retrenchment of rival output. By itself, this retrenchment increases the profits of that particular type of entrant, thereby encouraging additional entry that raises social welfare. The opposite incentive exists when an entrant of a given marginal-cost type is oversubsidized. Of course, the output choice for any marginal-cost type also depends on how the subsidy paid to that cost type affects the subsidies received by lower-cost entrants (and the associated welfare implications for those cost types).

information.[29] Consequently, there is an unavoidable loss of welfare. This result arises because the policymaker cannot induce additional entry without increasing the overall subsidy payment to a given cost type, thereby increasing the subsidy paid to entrants with lower fixed costs that would have entered the market at existing subsidy levels. The increased subsidy payment to these foreign entrants lowers domestic welfare. This type of *information cost* is unique to the case of foreign entry. It does not arise under domestic entry (unless the social value of each unit of government revenue exceeds one) because the increased subsidy is merely an increased transfer payment from the government to domestic entrants.

5. Concluding Remarks

This paper provides an explanation of government policy toward entry. Based on the unilateral incentives of policymakers to maximize domestic welfare, we identify conditions where policymakers should allow free entry and selectively promote entry, and conditions where they should deter entry. In certain cases, the decision to allow entry depends on the entrant's expected output level. Lower-cost firms may be permitted to enter, while higher-cost firms may be deterred from entering the market.

In general, entry policy evolves as market structure changes. As domestic firms become more prominent in the market, policymakers have stronger incentives to deter further entry.

Our analysis also shows that a policy permitting free entry should be coupled with a policy that subsidizes entry under appropriate circumstances, regardless whether the entrant is a domestic or foreign firm. With complete information concerning the entrant's costs, the optimal subsidy mechanism consists of a per-unit output subsidy and a lump-sum subsidy or tax, where both domestic and foreign entrants

[29] Proof available from authors. Output choices are also inefficient. Assuming that the distributions of marginal and fixed costs are uniformly and independently distributed (and that demand is linear), it can be shown that foreign entrants with particularly high marginal costs, and those with particularly low marginal costs, produce more than the "constrained" welfare-maximizing output level for their cost types (*i.e.*, the output level that satisfies equation (17)). Other entrant types may produce more or less than this output level.

receive the same output subsidy.

With incomplete cost information, the optimal entry subsidy should treat domestic and foreign entry differently. Optimizing behavior implies that the policymaker should undersubsidize foreign entry. Moreover, the policymaker should undersubsidize domestic entrants with relatively high marginal costs and oversubsidize domestic entrants with relatively low marginal costs. However, in subsidizing domestic entry, any potential welfare losses under incomplete information can be avoided if the policymaker can induce the entrant to act as a Stackelberg leader.

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