THREE ESSAYS IN INDUSTRIAL ECONOMICS AND PUBLIC POLICY

by

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B.E., King Mongkut's Institute of Technology Ladkrabang, 1996
M.E., Kasetsart University, 2004

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Economics
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Abstract

This dissertation comprises of three essays in industrial economics. My first essay analyzes social efficiency of entry into a downstream oligopoly of a vertical market structure, where an upstream supplier sells an essential input to all firms producing downstream. In the downstream markets, a multiproduct firm is both a monopoly in its own product and a leader in a different product market with free entry of followers. We show that in the presence of scale economies, entry is socially insufficient. The insufficiency of entry is due to the fact that entry generates a business-creating effect significantly large enough to dominate a business-stealing effect, regardless of whether the upstream supplier's input pricing strategy is discriminatory or uniform. This suggests that entry regulation as a public policy is socially undesirable in the downstream oligopoly of a vertical market structure.

My second essay examines differences in welfare implications between discriminatory and uniform input price regimes in vertically related markets where a multiproduct firm operates downstream in two separate markets: one is a monopoly and the other is an oligopoly with entry of new firms. In the analysis, we analyze how the downstream entry into the oligopolistic market affects social efficiency. In an open economy, whether the input price regime is discriminatory or uniform, entry is always socially excessive in the presence of scale economies. This contrasts with the existing studies in the literature that entry is always socially insufficient in an open economy with the presence of scale economies.

Focusing on the scenario where vertically integrated producer (VIP) adopts a non-foreclosure strategy, my third essay shows that downstream entry is socially insufficient despite scale economies and the marginal cost difference between the VIP and its retail competitors. The non-foreclosure equilibrium arises when the VIP's wholesale profit from the sales of an essential input is sufficiently large and the VIP shares the profit with its downstream competitors. For the case of an open economy where the VIP is a foreign firm, downstream entry continues to be socially insufficient. Entry regulation is therefore socially undesirable, but a production subsidy encouraging downstream entry is shown to be a welfare-improving policy.

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I wish, one day in the coming future, I will have a chance to pay back for these people who have supported me.

Dedication

I dedicate my dissertation to my parents, my brother and sisters.

Chapter 1 - Social Efficiency of Downstream Entry in Vertically Related Markets with Multiproduct Leaders

1.1 Introduction

Whether entry into a market is socially excessive or not constitutes an important regulatory issue to governments or policy makers of many countries.[1] Economists have helped identify a set of primary variables that determine the welfare implications of entry under imperfect competition. These variables include the presence of scale economies, market structure (in terms of the number of firms), competition models adopted by rival firms, as well as differences in marginal costs of production between competing firms, etc. The seminal contribution by Mankiw and Whinston (1986) indicates that under oligopoly with no integer constraint, the presence of scale economies makes entry socially excessive. Ghosh and Morita (2007) demonstrate for the case of a successive vertical oligopoly that free entry equilibrium can be socially insufficient rather than excessive. Herweg and Muller (2012) show that entry can be either socially insufficient or excessive, depending on whether there is input price discrimination and whether the number of firms in the downstream industry is exogenously given. Mukerjee (2012) shows that in the absence of scale economies, entry is always socially insufficient. In the presence of scale economies, Mukerjee (2012) further indicates that entry remains to be socially insufficient when the marginal cost differential between market leader and followers is significantly large.

In this paper, we examine social efficiency of downstream entry in vertically related markets. Specifically, we analyze and compare effects that alternative input pricing regimes (discriminatory vs. uniform) have on downstream entry in order to see if entry is socially

[1] See, for example, Suzumura and Kiyono (1987) and Suzumura (1995).

excessive or insufficient. As in Mukerjee (2012), we pay special attention to competition between a market leader and followers. But unlike Mukerjee (2012), we consider that a market leader is a multiproduct firm in both of the downstream output markets. We further examine the scenario where an upstream input monopolist supplies an essential input to all firms producing downstream. In the downstream markets, a multiproduct firm is both a monopoly in its own product and a leader in a different product market with free entry of followers. The upstream monopolist may adopt a discriminatory pricing strategy by charging different input prices between the multiproduct firm and the followers. Alternatively, the upstream monopolist may adopt a uniform pricing strategy for its input, charging an identical price to all downstream buyers. We wish to see whether differences in input pricing regimes affect the welfare implications of downstream entry differently.

It should be mentioned that the standard logic behind price concessions is applied to input pricing determined by an upstream monopolist supplier. This implies that downstream firms whose markets have lower demands are apt to receive an input price concession. Thus, when one market has higher demand than another market, under input price discrimination the multiproduct firm (the leader) would receive input price concession. That is, the input price for the multiproduct firm is lower than that for the followers. On the other hand, under uniform input pricing, if the oligopolistic market with free entry has a higher demand than the monopoly market, the input price for the multiproduct firm (the leader) will be higher than that for the firm under input price discrimination. This is because the price concession is applied to all firms equally. However the downstream followers will get a lower input price under uniform input pricing than under input price discrimination. The pros and corns between uniform pricing and price discrimination upon social welfare have long been debated. Arya and Mittendorf (2010) show that input price discrimination can provide welfare gains by giving price concessions to less efficient firms. They indicate that when markets have lower demand and lower competition, price discrimination stifles the social efficiency by shifting output to less competitive markets. This notion contrasts to Bork's (1978) defending about price discrimination and concludes that the uniform pricing can offer significant welfare benefits. Whereas Katz (1987), Yoshida (2000) and Valletti (2003) also support the notion that price discrimination can provide welfare benefits by siphoning the production to the less efficient sources.

Apart from two alternative input pricing regimes, it is instructive to see economic reasons behind the insufficient and excessive entry. There are two effects associated with entry: one is a business-stealing effect and the other is a business-creating effect. A business-stealing effect arises when entry steals business from an incumbent which suffers a loss in the volume of sales. On the other hand, a business-creating effect emerges when entry creates business to an incumbent by increasing its volume of sales. From the perspective of a social planner, every business system has both business-stealing and business-creating effects associated with entry. It is important to identify conditions under which one effect dominates the other. If entry is such that the business-stealing effect is dominated by the business-creating effect, entry is deemed to be socially insufficient. On the contrary, if the business-stealing effect dominates the business-creating effect, such entry is socially excessive. In our analysis, we consider the case that all firms in the downstream oligopolistic market incur set-up costs and that the upstream input supplier adopts either a discriminatory or a uniform pricing scheme. We show that the business-stealing effect is dominated by the business-creating effect, with the consequence that entry into the downstream oligopoly of a vertical market structure is socially insufficient. We therefore infer that downstream entry regulation is not socially effective from the welfare maximization perspective.

The remainder of this chapter is organized as follows. Section 1.2 describes the model of a vertically related market structure. In Section 1.3, we discuss welfare implications of downstream entry when the upstream input supplier adopts either a discriminatory or a uniform input pricing scheme. Section 1.4 concludes.

1.2 The Simple Model of Vertically Related Markets

We consider a simple vertical structure in which there is an upstream monopoly supplier selling an essential input to all firms producing downstream. In the downstream markets, a multiproduct firm is a Stackelberg leader in an oligopolistic market for a homogenous good (denoted as A) and is a monopoly in its own product (denoted as B). There are potential entrants wanting to produce good A. If an entrant decides to enter the oligopolistic market, it incurs a fixed cost $k(>0)$, and behaves as a Stackelberg follower. We wish to examine welfare implications of entry into the downstream oligopolistic market of a vertical structure.

For analytical simplicity, we assume that the production cost of the upstream monopoly supplier is zero and that all firms in the downstream markets require one unit of the essential input to produce one unit of output. We further assume that the leader and followers in the oligopolistic market incur set-up costs and that all the followers in this market are identical in all aspects.

The (inverse) demand in the downstream oligopolistic market is assumed to be linear: $P_A = \alpha_A - q_L - \sum_{i=1}^{n} q_i$, where P_A is price of product A, and q_L and q_i are the quantities of the good produced by the leader and the i^{th} follower (i = 1,…, n) respectively, α_A represents the size or demand of the market. The (inverse) demand in the downstream monopoly market is taken to be: $P_B = \alpha_B - y_L$, where P_B and y_L are the price and quantity of product B, and α_B represents its market size or demand.

Two alternative pricing schemes may be adopted by the upstream supplier selling an essential input, X. One is discriminatory pricing, under which one input price w_L is charged to the multiproduct leader and another input price w_i is charged to each of the followers in the oligopolistic market, where $w_L \neq w_i$. The other is uniform pricing, under which an identical price w is charged to all input buyers.

The analysis involves a three-stage game. At stage one, the upstream input monopolist sets its prices that maximize total profits. At stage two, the multiproduct leader makes its output decisions to maximize joint profits from the two downstream markets. At stage three, each entrant as a follower in the oligopolistic market determines its output to maximize individual profit. In what follows, we employ backward induction to solve for the subgame perfect Nash equilibrium for each input pricing scheme.

1.2.1 Downstream Entry under Input Price Discrimination

Under this regime, discriminatory input prices are charged to the multiproduct leader and each follower in the oligopolistic market. Given input price w_i, the i^{th} follower at the third stage of the game chooses output q_i to maximize its total profit, assuming that the leader's output q_L and the outputs of all other followers remain unchanged. The profit maximization problem of the i^{th} follower is:

$$\underset{\{q_i\}}{Max}\ \pi_i = \left(\alpha_A - q_L - \sum_{i=1}^{n} q_i - w_i\right) q_i - k.$$

Solving for the optimal output level of the i^{th} follower yields

$$q_i = \frac{\alpha_A - q_L - w_i}{n+1} \text{ for } i = 1, \ldots, n. \tag{1}$$

Given a different input price w_L, the multiproduct leader at the second stage of the game solves the joint profit maximization problem:

$$\underset{\{q_L, y_L\}}{Max}\ \pi_L = [(\alpha_A - q_L - \sum_{i=1}^{n} q_i) - w_L] q_L + (\alpha_B - y_L - w_L) y_L - k,$$

where q_i is given in (1). Under the assumption of symmetry that followers are identical in all aspects, we solve for the leader's equilibrium outputs:

$$q_L = \frac{\alpha_A - w_L(n+1) + nw_i}{2}, \tag{2a}$$

$$y_L = \frac{\alpha_B - w_L}{2}. \tag{2b}$$

Using (1) and (2a), we calculate output of each follower as

$$q_i = \frac{\alpha_A - w_i(n+2) + w_L(n+1)}{2(n+1)}. \tag{2c}$$

From (2a) and (2c), we see that an increase in w_i raises the output of the leader and lowers the output of each follower. Similarly, an increase in w_L raises the output of each follower and lowers the output of the multiproduct leader.

At the first stage of the game, the upstream input monopolist determines an optimal pricing structure, $\{w_L, w_i\}$, by solving the following profit maximization problem:

$$\underset{\{w_L, w_i\}}{Max}\ \pi_s = (w_L q_L + w_L y_L) + nw_i q_i,$$

where $q_{L,}\ y_L$, and q_i are respectively given in (2a), (2b), and (2c). The first-order conditions with respect to w_L and w_i lead to the optimal input prices:

$$w_L^{PD} = \frac{2\alpha_A(n+1)+\alpha_B(n+2)}{2(3n+4)}, \tag{3a}$$

$$w_i^{PD} = \frac{\alpha_A(2n+3)+\alpha_B(n+1)}{2(3n+4)}, \tag{3b}$$

where the subscript "*PD*" represents the case of input price discrimination. Under discriminatory pricing, the optimal input prices reflect a two-fold averaging across both downstream markets and firms.[2]

Substituting the input prices from (3a)-(3b) back into (2a)-(2c), we have the equilibrium outputs of the leader and the followers respectively:

$$q_L^{PD} = \frac{\alpha_A(5n+6)-\alpha_B(2n+2)}{4(3n+4)}, \tag{4a}$$

$$y_L^{PD} = \frac{\alpha_B(5n+6)-\alpha_A(2n+2)}{4(3n+4)}, \tag{4b}$$

$$q_i^{PD} = \frac{\alpha_A}{4(n+1)}. \tag{4c}$$

To determine the total amount of the input, X, sold to all the downstream buyers, we note that $X^{PD} = q_L^{PD} + y_L^{PD} + nq_i^{PD}$ under the assumption that one unit of output requires one unit of input in production. Substituting q_L^{PD}, y_L^{PD}, and q_i^{PD} from (4a)-(4c) into this expression yields

$$X^{PD} = \frac{\alpha_A(2n+1)+\alpha_B(n+1)}{4(n+1)}. \tag{4d}$$

[2] This finding contrasts with the result of Arya and Mittendorf (2010). The authors show that under Cournot competition, input prices reflect only the averaging of demand conditions of the two downstream markets.

Making use of (4a)-(4d), we have the comparative statics of downstream entry:

$$\frac{\partial q_L^{PD}}{\partial n} = \frac{\alpha_A - \alpha_B}{2(3n+4)^2} > (<) 0 \text{ when } \alpha_A > (<) \alpha_B, \tag{5a}$$

$$\frac{\partial y_L^{PD}}{\partial n} = \frac{\alpha_B - \alpha_A}{2(3n+4)^2} < (>) 0 \text{ when } \alpha_A > (<) \alpha_B, \tag{5b}$$

$$\frac{\partial q_i^{PD}}{\partial n} = -\frac{\alpha_A}{4(n+1)^2} < 0, \tag{5c}$$

$$\frac{\partial X^{PD}}{\partial n} = \frac{\alpha_A}{4(n+1)^2} > 0. \tag{5d}$$

Equations (5a) and (5b) indicate the differences in demands between the two downstream markets when entry affects the equilibrium outputs of the leader. If demand in the oligopolistic market exceeds that in the monopoly market, entry increases the leader's output in the oligopolistic market but decreases its output in the monopoly market. This suggests that entry generates a "business-creating effect" in the oligopolistic market but a "business-stealing effect" in the monopoly market. If, instead, demand in the oligopolistic market is lower than demand in the monopoly market, entry generates a business-stealing effect in former market and a business-creating effect in the latter market. These two conflicting effects thus depend on the market demand differential. Nevertheless, for any differences of demand conditions between the two downstream markets, entry generates both effects to the leader from each market equally so that the equilibrium outputs of the leader are independent of entry.

For each follower, we have from (5c) that entry generates a business-stealing effect. For the upstream supplier, we have from (5d) that entry generates a business-creating effect.

The net equilibrium profits for the input supplier, the downstream leader and its competition are given, respectively, as

$$\pi_S^{PD} = \frac{\alpha_A^2\left(4n^2+7n+2\right)+\alpha_B^2\left(n^2+3n+2\right)+\alpha_A\alpha_B\left(4n^2+8n+4\right)}{8\left(3n+4\right)\left(n+1\right)}, \tag{6}$$

$$\pi_L^{PD} = \frac{\alpha_A^2\left(4n^3+37n^2+72n+40\right)+\alpha_B^2\left(25n^3+89n^2+104n+40\right)-\alpha_A\alpha_B\left(20n^3+84n^2+112n+48\right)}{16\left(3n+4\right)^2\left(n+1\right)}-k, \tag{7}$$

$$\pi_i^{PD} = \frac{\alpha_A^2}{16\left(n+1\right)^2}-k. \tag{8}$$

Next, we analyze how downstream entry affects social welfare by comparing the equilibrium number of followers under market conditions, denoted by n^*, and the one determined by the social planner, denoted by $\hat{n}$. If n^* equals $\hat{n}$, entry is socially optimal; if n^* is greater than $\hat{n}$, entry is socially excessive; but if n^* is less than $\hat{n}$, entry is socially insufficient. We firstly determine the equilibrium number of followers under market conditions. Using the zero-profit condition,

$$\pi_i^{PD} = \frac{\alpha_A^2}{16\left(n+1\right)^2}-k=0, \tag{9a}$$

we solve for the number of the followers in the free-entry equilibrium as

$$n^* = \frac{1}{4\sqrt{k}}\alpha_A-1. \tag{9b}$$

Next, we determine the socially optimal number of the followers from the social planner's perspective. The objective is to maximize overall welfare, which is taken to be the sum of the upstream input supplier's profits, the profits of the leader the followers in the downstream markets, and consumer surplus in both markets. That is, the social planner solves the following welfare maximization problem:

$$\underset{\{\hat{n}\}}{Max}\ SW^{PD} = \pi_s^{PD} + \pi_L^{PD} + n\pi_i^{PD} + CS_A^{PD} + CS_B^{PD},$$

where π_s^{PD}, π_L^{PD}, and π_i^{PD} are given by (6), (7), and (8), respectively, $CS_A^{PD} = (q_L^{PD} + nq_i^{PD})^2/2$, and $CS_B^{PD} = (y_L^{PD})^2/2$. Taking the first-order derivative of SW^{PD} with respect to n, setting the resulting expression to zero, we have

$$\frac{\alpha_A^2(40n^4+239n^3+522n^2+498n+176)+\alpha_B^2(10n^4+46n^3+78n^2+58n+16)+\alpha_A\alpha_B(4n^4+12n^3+12n^2+4n)}{16(3n^2+7n+4)^3} - k = 0. \quad (10)$$

This FOC defines the socially optimal number of the entrants (denoted as $\hat{n}$) in the downstream oligopolistic market.

Evaluating the left hand side of (10) at the point where $n = n^*$ as given in (9b), we show in Appendix A-1 that

$$\left.\frac{\partial SW^{PD}}{\partial n}\right|_{n=\frac{1}{4\sqrt{k}}\alpha_A - 1} > 0.$$

The strict concavity of the social welfare function implies that the equilibrium number of the followers under market conditions is less than the socially optimal number of the followers. That is, $n^* < \hat{n}$. We thus have

PROPOSITION 1. *Under input price discrimination with the presence of scale economies and a multiproduct leader in a downstream oligopolistic market, entry into the downstream market is socially insufficient.*

The intuition behind Proposition 1 is as follows. Under input price discrimination, downstream entry generates the business-creating effect to benefit the upstream input supplier. This result emerges, regardless of differences in demands between the downstream markets. For the leader serving both of the downstream markets, if demand in the oligopolistic market exceeds demand in the monopoly market, entry generates a business-creating effect in the oligopolistic market and a business-stealing effect in the monopoly market. If, instead, demand in the monopoly market exceeds demand in the oligopolistic market, entry generates a business-creating effect in the monopoly market but a business-stealing effect in the oligopolistic market. Hence, from the leader's perspective, entry has a business-creating effect in the market with a higher demand and a business-stealing effect in the market with a lower demand. Nevertheless, for the leader the business-creating effect and the business-stealing effect cancel out each other, for any differences in demands. Consequently, entry does not have any business effect for the leader. For the followers, however, entry always results in a business-stealing effect regardless of differences in market demands between the two output markets.

The strength of both business effects is shown to depend on the differences in demand conditions of the two downstream markets. This implies that both business effects directly affect overall welfare. We thus can infer that under discriminatory input pricing with scale economies and market leader, the business-creating effect always dominates the business-stealing effect, with the consequence that entry is socially insufficient.

1.2.2 Downstream Entry under Uniform Input Pricing

Under this regime, the upstream supplier charges an identical price for its input to all downstream firms. Given input price *w*, the follower i^th for i = 1, 2… n chooses its output q_i to maximize its own profit $\prod_i$, taking the outputs of rival firms as given. Formally, the i^th follower's profit maximization problem is:

$$\underset{\{q_i\}}{Max}\ \pi_i = \left[\left(\alpha_A - q_L - \sum_{i=1}^{n} q_i\right) - w\right] q_i - k$$

Using the FOC for the i^th follower, we solve for its output as a function of the leader's output:

$$q_i = \frac{\alpha_A - w - q_L}{n+1} \tag{11}$$

The multiproduct leader determines its output decisions by choosing q_L and y_L that solve for the following joint profit maximization problem:

$$\underset{\{q_L, y_L\}}{Max}\ \pi_L = \left[\alpha_A - q_L - \frac{n\left(\alpha_A - q_L - w\right)}{n+1} - w\right] q_L + \left(\alpha_B - y_L - w\right) y_L - k$$

The FOCs with respect to q_L and y_L yield the equilibrium outputs of the leader as

$$q_L = \frac{\alpha_A - w}{2}, \tag{12a}$$

$$y_L = \frac{\alpha_B - w}{2}. \tag{12b}$$

Using (11) and (12a), we calculate the output of each follower to be

$$q_i = \frac{\alpha_A - w}{2\left(n+1\right)} \tag{12c}$$

The upstream input monopolist determines an optimal price solving the following profit maximization problem:

$$\underset{\{w\}}{Max}\ \pi_s = \left(q_L + y_L + nq_i\right) w \tag{13}$$

Substituting (12a)-(12c) into π_s in (13), we set the derivative $d\pi_s / dw$ to zero and solve for the optimal input price as

$$w^{UP} = \frac{\alpha_A\left(2n+1\right) + \alpha_B\left(n+1\right)}{2(3n+2)}. \tag{14}$$

where the subscript "*UP*" represents the case of uniform pricing. The result in (14) indicates that the equilibrium input price reflects a two-fold averaging across both downstream markets and firms.

Substituting w^{UP} from (14) back into (12a)-(12c), we obtain the equilibrium outputs of the leader and each follower as follows:

$$q_L^{UP} = \frac{\alpha_A(4n+3) - \alpha_B(n+1)}{4(3n+2)}, \tag{15a}$$

$$y_L^{UP} = \frac{\alpha_B(5n+3) - \alpha_A(2n+1)}{4(3n+2)}, \tag{15b}$$

$$q_i^{UP} = \frac{\alpha_A(4n+3) - \alpha_B(n+1)}{4(3n+2)(n+1)}. \tag{15c}$$

To determine the total amount of the input X sold by the upstream supplier to all downstream buyers, we note that $X^{UP} = q_L^{UP} + y_L^{UP} + nq_i^{UP}$. Substituting q_L^{UP}, y_L^{UP}, and q_i^{UP} from (15a)-(15c) into this expression yields

$$X^{UP} = \frac{\alpha_A(2n+1) + \alpha_B(n+1)}{4(n+1)}. \tag{15d}$$

From (15a)-(15d), we have the comparative statics of downstream entry:

$$\frac{\partial q_L^{UP}}{\partial n} = \frac{\alpha_B - \alpha_A}{4(3n+2)^2} < (>)0 \text{ when } \alpha_A > (<)\alpha_B, \tag{16a}$$

$$\frac{\partial y_L^{UP}}{\partial n} = \frac{\alpha_B - \alpha_A}{4(3n+2)^2} < (>)0 \text{ when } \alpha_A > (<)\alpha_B, \tag{16b}$$

$$\frac{\partial q_i^{UP}}{\partial n} = \frac{\alpha_B(3n^2+6n+3) - \alpha_A(12n^2+18n+7)}{4(3n+2)^2(n+1)^2} < (>)0 \text{ when } \alpha_A > (<)\alpha_B, \tag{16c}$$

$$\frac{\partial X^{UP}}{\partial n} = \frac{\alpha_A}{4(n+1)^2} > 0. \tag{16d}$$

Equations (16a) and (16b) indicate that differences in demands between the downstream markets play an important role in determining how entry affects the equilibrium outputs of the market leader. When the two markets are identical in demands, entry exerts no effects on the leader's output decisions. However, when differences of the demand conditions between oligopolistic market and monopolistic market are small, entry reduces the outputs of the leader in both markets slightly. In addition, if this difference is significantly large, entry lowers the outputs of the leader in both markets extremely. On the other hand when the difference of the demand conditions between monopoly market and oligopolistic market is small, entry will increase the outputs of the leader for both markets slightly and when this difference is significantly large, entry will extremely raise the outputs of the leader in both markets. For each follower, we have from equation (16c) that entry will increase the output only when the demand condition of monopoly market is significantly larger than oligopolistic market and entry will decrease the output for vice versa.

Because the uniform pricing reflects a two-fold averaging both across markets and across firms, entry affects the input price and the strength of which depends on the difference in demand conditions between the downstream markets. If the difference is significantly large, the strength of this effect will be extremely strong. For the upstream supplier, we have from equation (16d) that entry will always increase the total amount of the input to be sold in both of the downstream markets. Consequently, there is a business-creating effect resulting from entry. In conclusion, under uniform pricing, if the demand condition of oligopolistic market is larger than monopolistic market then all firms in the downstream market will incur the business-stealing effect except the upstream supplier that will have the business-creating effect. But if the demand condition of the monopolistic market is larger than that of the oligopolistic market, all firms in the downstream market and upstream supplier will incur the business-creating effect.

The net equilibrium profits of the supplier, the leader, and the ith follower for i = 1, 2… n are given, respectively, as

$$\pi_S^{UP} = \frac{[\alpha_A(2n+1)+\alpha_B(n+1)]^2}{8(n+1)(3n+2)}, \tag{17}$$

$$\pi_L^{UP} = \frac{\alpha_A^2(4n^3+24n^2+29n+10)+\alpha_B^2(25n^3+56n^2+41n+10)-\alpha_A\alpha_B(20n^3+50n^2+42n+12)}{16(n+1)(3n+2)^2}-k, \tag{18}$$

$$\pi_i^{UP} = \frac{[\alpha_A(4n+3)-\alpha_B(n+1)]^2}{16(n+1)^2(3n+2)^2}-k. \tag{19}$$

Next we show how entry affects social efficiency by comparing the equilibrium number of followers under market conditions, denoted by n^{**}, and the one determined by the social planner, denoted by $\tilde{n}$. To solve for the equilibrium number of followers under market conditions, we use the following zero-profit condition:

$$\pi_i^{UP} = \frac{[\alpha_A(4n+3)-\alpha_B(n+1)]^2}{16(n+1)^2(3n+2)^2}-k=0, \tag{20a}$$

and find that

$$n^{**} = \frac{4\alpha_A-\alpha_B-20\sqrt{k}+\sqrt{16\alpha_A^2+\alpha_B^2-8\alpha_A\alpha_B-16\sqrt{k}\alpha_A-8\sqrt{k}\alpha_B+16k}}{24\sqrt{k}}. \tag{20b}$$

For determining the socially optimal number of the followers, we assume that the objective of the social planner is to maximize overall welfare, which is the sum of firm profits and consumer surplus in the vertically related markets. That is, the social planner solves the following welfare maximization problem:

$$\underset{\{\tilde{n}\}}{Max}\ \mathrm{SW}^{UP} = \pi_S^{UP} + \pi_L^{UP} + n\pi_i^{UP} + CS_A^{UP} + CS_B^{UP},$$

where π_S^{UP}, π_L^{UP}, and π_i^{UP} are given by (17), (18), and (19), respectively, $CS_A^{UP} = (q_L^{UP} + nq_i^{UP})^2/2$, and $CS_B^{UP} = (y_L^{UP})^2/2$. Taking the first-order derivative of SW^{UP} with respect to n, setting the resulting expression to zero, we have

$$\frac{\alpha_A^2(38n^4+149n^3+201n^2+115n+24)+\alpha_B^2(5n^4+19n^3+27n^2+17n+4)+\alpha_A\alpha_B(11n^4+21n^3+6n^2-8n-4)}{16(n+1)(3n+2)} - k = 0. \tag{21}$$

This FOC defines the socially optimal number of the entrants (denoted as $\tilde{n}$) in the downstream oligopolistic market.

Evaluating the left hand side of (21) at the point $n = n^{**}$ as derived in (20b), we show in Appendix A-2 that

$$\left.\frac{\partial SW^{UP}}{\partial n}\right|_{n=n^{**}} > 0.$$

This implies that the equilibrium number of the followers under market conditions is less than the social optimal number of the followers. That is, $n^{**} < \tilde{n}$. As a result, entry under this regime is socially insufficient.

PROPOSITION 2: *Under uniform input pricing with the presence of scale economies and a multiproduct leader in a downstream oligopolistic market, entry into the downstream market is socially insufficient.*

The intuition for the proposition 2 is as follows. Under uniform input pricing, entry can create the business-creating effect to the supplier for any differences of the demand conditions between the two downstream markets. For the leader, when the demand condition in downstream monopoly market is larger than downstream oligopolistic market, entry will create the business-creating effect for both downstream markets. However, entry will create business-stealing effect for both downstream markets when the demand condition in downstream oligopolistic market is larger than downstream monopoly market. The strength of both effects will depend on the difference of the demand conditions between the two downstream markets so the larger of the difference of the demand conditions, the stronger of the business effects.

For the follower, entry generates a business creating effect only when the difference of the demand conditions between the downstream monopoly market and downstream oligopolistic market is significantly large. Otherwise, entry generates a business-stealing effect instead. As a result, when there is a significantly difference of the demand conditions between the two downstream markets, entry generates a significant effect on social welfare. However, when there is a significant difference of the demand conditions between the two downstream markets, the business-creating effect always dominates the business-stealing effect and entry is always socially insufficient.

1.3 Concluding Remarks

In this paper, we focus our analysis on a vertically related market structure to examine the social efficiency of downstream entry under different input pricing regimes provided by the upstream supplier. Competition in the downstream oligopolistic market is characterized by a Stackelberg leader-follower game with the leader being a multiproduct firm operating as a monopolist in its own product market. We show that in the presence of scale economies the alternative input price regimes (discriminatory vs. uniform) did not determine the effect of downstream entry to the oligopolistic market on social welfare; entry is always socially insufficient for both pricing regimes. As a result, entry regulation may not be justified in a downstream oligopoly of a vertical market structure.

Chapter 2 - Input Price Discrimination vs. Uniform Pricing in Vertically Related Markets with Downstream Entry

2.1 Introduction

The primary objective of this paper is to analyze how alternative input price regimes (discriminatory vs. uniform) and downstream entry affect social efficiency in vertically related markets. The vertical structure is composed of a foreign upstream supplier selling an essential input to domestic downstream purchasers operating in two different markets, one is oligopolistic and the other is monopolistic. In the oligopolistic market, an incumbent firm and entrants engage in Cournot competition. In the monopoly market, the incumbent firm sells a different product in its own market. The upstream supplier has the options of choosing between a discriminatory input pricing and a uniform input pricing. One of these phenomena can be frequently observed in developing countries when they have to import an essential input such as crude oil to produce final products in domestic markets. We consider the case that demand in the oligopolistic market is greater or identical to demand in the monopoly market. For analytical simplicity, we assume that the marginal cost of the upstream supplier is zero and that all firms in the oligopolistic market have an identical set-up cost.

The upstream input supplier has the options of offering either uniform or discriminatory input pricing to each firm producing downstream.[3] The consideration of an alternative input pricing regime is consistent with that Arya and Mittendorf (2010). Under input price

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[3] This input price discrimination which is one of the most common forms of price discrimination, third-degree price discrimination, means that different buyers are charged with different prices but each buyer pays a constant amount for each unit of the input they bought. This is different from first degree price discrimination and second degree price discrimination. For first degree price discrimination, the seller will charge a different price for each unit of input when the price charged for each unit of inputs is equal to the maximum willingness to pay for that unit. For the second degree price discrimination, the seller will charge different prices to each buyer and these different prices will depend on the number of unit of input bought, but not across customer.

discrimination, each firm is offered different input prices and the offering reflects an averaging of the demand conditions in which each firm operates.

Under uniform input pricing, each downstream firm is offered an identical input price and such offering reflects a two-fold averaging, across both markets and across all firms. Arya and Mittendorf (2010) also show that price concession will accrue to the weaker input buyers whose output markets have lower demand. Thus, under uniform input pricing and the oligopolistic market has a higher demand than the monopoly market, the input price for the multiproduct firm will be increased. As a result, the multiproduct firm has a higher incentive to produce more under input price discrimination than under uniform input pricing. The increased motivation for production of multiproduct firm under input price discrimination is welfare-enhancing. In our study, in which there are entrants into downstream oligopolistic market, the number of entrants exerts a significant effect on the optimal input price under the uniform pricing regime but not on the optimal input price under a discriminatory regime. The effect of downstream entry on input price under uniform input pricing is shown to depend on the demand conditions between the downstream markets. If the demand condition of the oligopolistic market is higher than that of the monopoly market, downstream entry increases the optimal input price charged by the input supplier. If the demand conditions of the two output markets are identical, downstream entry has no effect on input price. The increase in input price resulting from the entry is shown to be a key factor that creates either the business-stealing effect[4] or the business-creating effect[5] to each downstream firm.

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[4] The business-stealing effect exists when the equilibrium strategic response of existing firms to new entry results in their having a lower volume of sales.

[5] The business-creating effect exists when the equilibrium strategic response of existing firms to new entry results in their having a higher volume of sales.

Under input price discrimination, however, downstream entry generates an impact to the downstream oligopoly market through (i) a business-creating effect to the upstream supplier and (ii) a business-stealing effect to the incumbent firm and entrants. A great deal of contributions has studied how entry affects social welfare. In their seminal work, Mankiv and Whinston (1986) show that under oligopolistic homogenous market with no integer constraint and the presence of scale economies, entry is socially excessive so that entry restrictions are often socially desirable. Ghosh and Morita (2007) demonstrate that under a successive vertical oligopoly model incorporating vertical relationship between industries, the free entry equilibrium can be socially insufficient rather than excessive. Mukerjee (2012) shows that in the presence of scale economies, if the marginal cost difference between the leader and the follower is significantly large, entry is always socially insufficient and in the absence of scale economies, entry is always socially insufficient. Herweg and Muller (2012) show that entry can be either socially insufficient or excessive by permitting price discrimination in input markets and taking the downstream industry as exogenously given.

Next we will present some articles mentioning about the comparative advantage and disadvantage of uniform pricing and price discrimination onto social welfare. Subsequently, Bork's (1978) defenses about price discrimination and concludes that the uniform pricing can offer significant welfare benefits. Whereas the authors who support the notion that price discrimination can provide welfare benefits by siphoning the production to the less efficient sources compose of Katz (1987), Yoshida (2000), Arya and Mittendorf (2010) and Chen, Hwang and Peng (2011).

Katz (1987) demonstrates that intermediate good price discrimination may shift prices in a way that reduces output in the final good market and thus lower consumer's surplus and welfare. However, this pricing regime may increase welfare by preventing socially inefficient integration. Yoshida (2000) shows that in a special case, when all downstream firms can be ordered in efficiency, price discrimination always reduces both the total output of the final good and welfare level. Nevertheless, in a general case, input-market price discrimination can lower or raise the total output of the final good and welfare level. Arya and Mittendorf (2010) demonstrate that price discrimination can provide welfare gains by giving price concessions to less efficient firms. They show that when the markets have lower demand and lower competition, price discrimination will stifle the social efficiency by shifting output to less competitive markets. Chen, Hwang and Peng (2011) show that input price discrimination can create positive effect to social welfare under the condition that the positive output allocation efficiency effect outweighs the negative production efficiency effect.

The remainder of this chapter is organized as follows. Section 2.2 describes the model. Section 2.3 presents the results. Section 2.4 concludes.

2.2 The Analytical Framework

We consider a simple vertical structure in which there is a foreign upstream monopoly supplier selling an essential input to domestic buyers in two downstream markets: one is an oligopoly and the other is a monopoly. In the downstream oligopolistic market, there is Cournot competition between the incumbent firm and entrants. The incumbent firm in the oligopolistic market also operates as a monopolist in its own product market. For analytical simplicity, we impose the following assumptions: (i) the production cost of the upstream monopoly supplier equals to zero, (ii) all downstream firms require one unit of input to produce one unit of final output, (iii) demand in the oligopolistic market is greater or equal to demand in the monopoly market, (iv) the incumbent firm and entrants in the downstream oligopolistic market incur a set up cost *k* and all entrants in this market are similar.

Let the (inverse) demand in the downstream oligopolistic market be given as $P_A = \alpha_A - q_A - \sum_{i=1}^{n} q_i$, where P_A is market price, q_A and q_i are the quantities of the output produced by the incumbent firm and the ith entrant (for i = 1, 2… n) respectively, and α_A represents demand condition of the market. The (inverse) demand in the downstream monopoly market is assumed to be $P_B = \alpha_B - y_A$, where P_B and y_A are price and quantity of the incumbent firm, α_B represents demand condition of the monopoly market.

The foreign upstream monopoly supplier can provide two regulatory input pricing regimes between input price discrimination and uniform input pricing. Under input price discrimination, the supplier can provide different input prices to each downstream firm; in this case, the incumbent firm and entrants pay w_A and w_i respectively. Under uniform input pricing, the supplier will provide the same input price to all buyers; in this case, each firm pays *w* for each unit of input. In the following analysis, we employ backward induction to identify the subgame perfect Nash equilibria.

2.2.1 Input Price Discrimination

Under this input pricing regime, the supplier charges separated prices for inputs to the incumbent firm and entrants. Given input price w_i , the ith entrant for i = 1, 2… n chooses its output q_i to maximize its total profit and takes its rival output q_A as given. Formally, firm ith problem is:

$$\underset{\{q_i\}}{Max} \ \Pi_i = \left(\alpha_A - q_A - \sum_{i=1}^{n} q_i - w_i\right) q_i - k.$$

Similarly, given input price w_A, the incumbent firm chooses its outputs q_A and y_A to maximize its total profit and takes its rival output q_i as given. Formally, the incumbent firm problem is:

$$\underset{\{q_A, y_A\}}{Max} \Pi_A = \left(\alpha_A - q_A - \sum_{i=1}^{n} q_i - w_A\right) q_A + \left(\alpha_B - y_A - w_A\right) y_A - k.$$

Solving for the outputs of the i[th] entrant and the incumbent firm, we have

$$q_i = \frac{\alpha_A - 2w_i + w_A}{n+2} \text{ for } i = 1, \ldots, n, \tag{1a}$$

$$q_A = \frac{\alpha_A - w_A\left(n+1\right) + nw_i}{n+2}, \tag{1b}$$

$$y_A = \frac{\alpha_B - w_A}{2}. \tag{1c}$$

We find that for the downstream oligopolistic market, an increase in w_A and w_i will raise the outputs of the entrant and incumbent firm respectively.

The supplier maximizes the following expression to determine input prices

$$\underset{\{w_A, w_i\}}{Max} \ \Pi_s = w_A\left(q_A + y_A\right) + nw_i q_i,$$

where q_i, q_A, and y_A are given in (1a), (1b), and (1c), respectively. Solving for the input prices yields

$$w_A^{PD} = \frac{\alpha_A + \alpha_B}{4}, \tag{2a}$$

$$w_i^{PD} = \frac{3\alpha_A + \alpha_B}{8}. \tag{2b}$$

Based on the discriminatory input prices in (2a) and (2b), we see that the input prices reflect an averaging of demand conditions in the downstream markets and that entry into the oligopolistic markets have no effects on input prices.

PROPOSITION 1 *Under input price discrimination, the optimal input prices reflect an averaging of demand conditions that each firm operates and downstream entry exerts no effect at all on these input prices.*

The intuition for Proposition 1 is as follows. Under input price discrimination, the input prices reflect an averaging of demand conditions that each firm operates which is consistent with the results of Arya and Mittendorf (2010). Because the incumbent firm operates in two separate markets and demand condition in one of which is lower, the firm obtains a price discount on input price from the upstream input supplier. The incumbent has a stronger incentive to increase its production under input pricing discrimination than uniform input pricing. The input price discount is one of the factors that affect overall welfare as a motivation for the incumbent firm to shift the production to lower demand market.

Substituting (2a)-(2b) back into (1a)-(1c), we calculate the equilibrium levels of outputs for the incumbent firm, the i^{th} entrant (for i = 1, 2… n), and the total input:

$$q_A^{PD} = \frac{\alpha_A(n+6) - \alpha_B(n+2)}{8(n+2)}, \tag{3a}$$

$$y_A^{PD} = \frac{3\alpha_B - \alpha_A}{8}, \tag{3b}$$

$$q_i^{PD} = \frac{\alpha_A}{2\,(n+2)}, \tag{3c}$$

$$X^{PD} = \frac{2\alpha_A(n+1) + \alpha_B(n+2)}{4(n+2)}. \tag{3d}$$

Making use of (3a)-(3d), we have the comparative statics of downstream entry:

$$\frac{\partial q_A^{PD}}{\partial n} = -\frac{\alpha_A}{2(n+2)^2} < 0, \tag{3e}$$

$$\frac{\partial y_A^{PD}}{\partial n} = 0, \tag{3f}$$

$$\frac{\partial q_i^{PD}}{\partial n} = -\frac{\alpha_A}{2(n+2)^2} < 0, \tag{3g}$$

$$\frac{\partial X^{PD}}{\partial n} = \frac{\alpha_A}{2(n+2)^2} > 0, \tag{3h}$$

Equations (3e)-(3h) indicate that entry lowers the output levels of the incumbent firm and entrants but increases the total input in the downstream markets. Hence, entry generates a business-stealing effect to the incumbent firm and entrants, but a business-creating effect to the upstream supplier. However, entry does not affect the outputs of the incumbent firm in the downstream monopoly market.

The net equilibrium profits for the supplier, the incumbent firm, and the i[th] entrant for i = 1, 2… n, are respectively:

$$\pi_S^{PD} = \frac{\alpha_A^2(3n+2)+\alpha_B^2(n+2)+\alpha_A\alpha_B(2n+4)}{16(n+2)}, \tag{4a}$$

$$\pi_A^{PD} = \frac{\alpha_A^2(n^2+8n+20)+\alpha_B^2(5n^2+20n+20)-\alpha_A\alpha_B(4n^2+20n+24)}{32(n+2)^2} - k, \tag{4b}$$

$$\pi_i^{PD} = \frac{\alpha_A^2}{4(n+1)^2} - k \text{ for } i = 1,\ldots,n. \tag{4c}$$

Next we examine the effect of downstream entry on social welfare. Using equation (4c), we have the following expressions for the zero-profit condition and the equilibrium number of followers under the market solution:

$$\pi_i^{PD} = \frac{\alpha_A^2}{4(n+1)^2} - k = 0, \tag{5a}$$

$$\tilde{n} = \frac{\alpha_A}{2\sqrt{k}} - 2. \tag{5b}$$

To evaluate whether $\tilde{n}$ in the downstream oligopolistic market is socially excessive or insufficient, we assume that there is a social planner with an objective of maximizing overall welfare by an optimal number of followers. Given that the upstream input supplier is a foreigner firm, its profit does not constitute a component of domestic welfare. The welfare maximizing number of the followers can be obtained by solving the following problem:

$$\underset{\{n\}}{Max}\ \mathrm{SW}^{\mathrm{PD}} = \pi_A^{PD} + n\pi_i^{PD} + CS^A + CS^B$$

which is

$$\underset{\{n\}}{Max} \frac{\alpha_A^2(15n^2+64n+60)+\alpha_B^2(15n^2+60n+60)-\alpha_A\alpha_B(16n^2+68n+72)}{64(n+2)^2} - k(n+1).$$

The first-order condition for welfare optimization is:

$$\frac{\partial SW^{PD}}{\partial n} = \frac{\alpha_A(2\alpha_A+2\alpha_B-n\alpha_A+n\alpha_B)}{16(n+2)^3} - k = 0. \tag{6}$$

Evaluating the first-order derivative $\partial SW^{PD}/\partial n$ at the point the value of n satisfies the zero-profit condition in (5b), we have

$$\left.\frac{\partial SW^{PD}}{\partial n}\right|_{n=\frac{\alpha_A}{2\sqrt{k}}-2} = -\frac{\alpha_A[\alpha_A(5n+6)-\alpha_B(n+2)]}{16(n+2)^3} < 0. \tag{7}$$

The strict concavity of the social welfare function implies that entry is socially excessive. We thus have

PROPOSITION 2 *Under input price discrimination, if the upstream input supplier is a foreign firm but the multiproduct firm and entrants are domestic firms, entry is always socially excessive for the domestic country, with the scale economies.*

The intuition for Proposition 2 is as follows. When the upstream input supplier is a foreign firm, its profit will be excluded from the welfare function. As a result, the domestic country determines its socially optimal number of entry by maximizing the sum of consumer surplus from oligopolistic market and monopoly market and total net profits of multiproduct firm and entrants. Since more entry decrease the outputs and profits of multiproduct firm and entrants, both of these effects create excessive entry of entrants in domestic country.

2.2.2 Uniform Input Pricing

Under this input pricing regime, the supplier provides the input price to all firms equally. Given its input price *w*, the i^th entrant for i = 1, 2… n chooses its output q_i to maximize its total profit Π_i, taking its rival output q_A as given. Formally, firm i^th's problem is:

$$\underset{\{q_i\}}{Max}\ \Pi_i = \left[\left(\alpha_A - q_A - \sum_{i=1}^{n} q_i\right) - w\right] q_i - k.$$

The incumbent firm determines the quantities of products q_A and y_A to be sold in downstream oligopolistic market and the monopoly market by maximizing its overall profits Π_A, taking as given its rival output q_i. Formally, the incumbent firm's profit maximization problem is:

$$\underset{\{q_A, y_A\}}{Max}\ \Pi_A = \left(\alpha_A - q_A - \sum_{i=1}^{n} q_i - w\right) q_A + \left(\alpha_B - y_A - w\right) y_A - k.$$

Solving for the output levels of the i^th entrant and the incumbent firm yields

$$q_i = \frac{\alpha_A - w}{n+2} \text{ for } i = 1, \ldots, n, \tag{8a}$$

$$q_A = \frac{\alpha_A - w}{n+2}, \tag{8b}$$

$$y_A = \frac{\alpha_B - w}{2}. \tag{8c}$$

The foreign supplier maximizes its total profit by determining an optimal input price w solving for the following problem:

$$\underset{\{w\}}{Max} \ \prod_s = \left(q_A + y_A + nq_i\right) w,$$

where the quantities of the input demanded by the downstream firms are given in equations (8a)-(8c). Solving for the optimal input price yields

$$w^{UP} = \frac{2\alpha_A(n+1) + \alpha_B(n+2)}{6n+8}. \tag{9}$$

Based on w^{UP} in (9) under uniform pricing, we see that the input price reflects a two-fold averaging both across markets and across firms. We, therefore, have

PROPOSITION 3 *Under uniform input pricing in a vertical market with downstream entry, the optimal input price reflects a two-fold averaging both across markets and across firms.*

The intuition for proposition 3 is as follows. Under uniform input pricing, the input price will reflect a two-fold averaging across markets and across firms. Under this input pricing regime, the upstream input supplier will provide the same input price to all firms and when the number of firms increases, the uniform input price will be increased. Nevertheless for the entrants, the uniform input price is still lower than discriminatory input price so the entrants prefer to produce under uniform input pricing than discriminatory input pricing. On the other hand for the incumbent firm, the uniform input price is higher than discriminatory input price so the incumbent firm prefers to produce under discriminatory input pricing than uniform input pricing.

Substituting w^{UP} from (9) back into (8a)-(8c), we obtain the equilibrium outputs of the incumbent firm, the i[th] entrant (for i = 1, 2… n), and the total input. These results are recorded as follows:

$$q_A^{UP} = \frac{2\alpha_A(2n+3) - \alpha_B(n+2)}{2(3n+4)(n+2)}, \tag{10a}$$

$$y_A^{UP} = \frac{\alpha_B(5n+6) - 2\alpha_A(n+1)}{4(3n+4)}, \tag{10b}$$

$$q_i^{UP} = \frac{2\alpha_A(2n+3) - \alpha_B(n+2)}{2(3n+4)(n+2)}, \tag{10c}$$

$$X^{UP} = \frac{\alpha_A(2n+2) + \alpha_B(n+2)}{4(n+2)}. \tag{10d}$$

Making use of (10a)-(10d), we have the comparative statics of downstream entry:

$$\frac{\partial q_A^{UP}}{\partial n} = \frac{\alpha_B(3n^2+12n+12) - \alpha_A(12n^2+36n+28)}{2\left(3n^2+10n+8\right)^2} < 0, \tag{10e}$$

$$\frac{\partial y_A^{UP}}{\partial n} = \frac{\alpha_B - \alpha_A}{2\left(3n+4)^2\right)} = (<)0, \quad \text{when } \alpha_B = (<)\alpha_A, \tag{10f}$$

$$\frac{\partial q_i^{UP}}{\partial n} = \frac{\alpha_B(3n^2+12n+12) - \alpha_A(12n^2+36n+28)}{2\left(3n^2+10n+8\right)^2} < 0, \tag{10g}$$

$$\frac{\partial X^{UP}}{\partial n} = \frac{\alpha_A}{2\left(n+2\right)^2} > 0, \tag{10h}$$

Equations (10e)-(10h) indicate that under uniform input pricing, entry and demand conditions between the downstream oligopolistic market and the downstream monopoly market will have the significant effect to the outputs of the incumbent firm and the entrants. For the incumbent firm, when the demand conditions of the two downstream markets are equal, there is no effect from the entry to the output in the downstream monopoly market but entry will decrease the output in the downstream oligopolistic market. Furthermore, when the demand condition of the downstream oligopolistic market is larger than the downstream monopoly market, entry will reduce the outputs for both markets. For the entrant, entry will decrease the output when the demand condition of downstream oligopolistic market is significantly larger or identical to the downstream monopoly market.

Because the uniform input pricing reflects a two-fold averaging both across markets and across firms, when the supplier provides the uniform input price to the buyers, entry will have significant effect to the input price and the strength of this effect will depend on the difference of the demand conditions. If the demand condition of the downstream oligopolistic market is significantly larger than the downstream monopoly market entry will extremely increase the input price. For the supplier, entry will increase the total inputs that will be sold in both downstream markets for any differences of the demand conditions.

Next, we calculate the net equilibrium profits of the supplier, the incumbent firm, and the i^{th} entrant (for i = 1, 2… n). These results are recorded as follows:

$$\pi_S^{UP} = \frac{\left[2\alpha_A(n+1)+\alpha_B(n+2)\right]^2}{8(3n+4)(n+2)}, \tag{11a}$$

$$\pi_A^{UP} = \frac{E-F}{16(n+2)^2(3n+4)^2} - k, \tag{11b}$$

where

$$E = 4\alpha_A^2(n^4+6n^3+29n^2+60n+40)+5\alpha_B^2(5n^4+32n^3+76n^2+80n+32\alpha_B^2),$$

$$F = \alpha_A\alpha_B(20n^4+124n^3+312n^2+384n+192),$$

and

$$\pi_i^{UP} = \frac{\left[2\alpha_A(2n+3) - \alpha_B(n+2)\right]^2}{4(3n+4)^2(n+2)^2} - k. \qquad (11c)$$

The equilibrium number of downstream entrants under market conditions is determined by the following zero-profit condition:

$$\pi_i^{UP} = \frac{\left[2\alpha_A(2n+3) - \alpha_B(n+2)\right]^2}{4(3n+4)^2(n+2)^2} - k = 0. \qquad (12a)$$

Solving for the optimal number of entrants yields

$$\tilde{n} = \frac{4\alpha_A - \alpha_B - 20\sqrt{k} + \sqrt{16\alpha_A^2 + \alpha_B^2 + 16k - 8\alpha_A\alpha_B - 16\sqrt{k}\alpha_A - 8\sqrt{k}\alpha_B}}{12\sqrt{k}}. \qquad (12b)$$

To evaluate whether $\tilde{n}$ in the downstream oligopolistic market is socially excessive or insufficient, we continue to assume that the social planner's objective to maximize overall welfare by solving the following problem:

$$\underset{\{n\}}{Max}\ \mathrm{SW}^{UP} = \pi_A^{UP} + n\pi_i^{UP} + CS^A + CS^B.$$

That is,

$$\underset{\{n\}}{Max}\ \frac{a\alpha_A^2 + b\alpha_B^2 - c\alpha_A\alpha_B}{32(n+2)^2(3n+4)^2} - k(n+1),$$

where

$$a = 76n^4 + 520n^3 + 1260n^2 + 1296n + 480,$$

$$b = 79n^4 + 512n^3 + 1220n^2 + 1264n + 480,$$

$$c = 92n^4 + 612n^3 + 1480n^2 + 1536n + 576.$$

The first-order derivative of SW^{UP} is:

$$\frac{\partial SW^{UP}}{\partial n} = \frac{\alpha_A^2 d + \alpha_B^2 e - \alpha_A \alpha_B f}{8(3n^2 + 10n + 8)^3} - k, \tag{13}$$

where

$d = -10n^4 + 18n^3 + 204n^2 + 360n + 192$,

$e = 11n^4 + 82n^3 + 228n^2 + 280n + 128,$

$f = n^4 + 46n^3 + 216n^2 + 352n + 192 + 576.$

Evaluating the first-order derivative $\partial SW^{UP} / \partial n$ in (13) at the point where the value of n satisfies the zero-profit condition in (12b), we have

$$\left.\frac{\partial SW^{UP}}{\partial n}\right|_{n=\tilde{n}} = -\frac{\alpha_A^2 g - \alpha_B^2 h - \alpha_A \alpha_B j}{8(n+2)^3 (3n+4)^3} < 0, \tag{14}$$

where

$g = 106n^4 + 590n^3 + 1228n^2 + 1128n + 384$,

$h = 5n^4 + 38n^3 + 108n^2 + 136n + 64,$

$j = 47n^4 + 282n^3 + 616n^2 + 576n + 192$.

The strict concavity of the social welfare function implies that entry is socially excessive. We, therefore, have

PROPOSITION 4 *Under uniform input pricing, if the upstream input supplier is a foreign firm but the multiproduct firm and entrants are domestic firms, entry is always socially excessive for the domestic country, with the scale economies.*

The intuition for Proposition 4 is as follows. Under uniform input pricing and the upstream input supplier is a foreign firm, entry is always socially excessive. Because entry will reduce both output and profit of the multiproduct firm and entrants, both of these effects create excessive entry of entrants in domestic country.

2.3 Concluding Remarks

We have analyzed and compared the effects of alternative input price regimes on overall welfare in vertically related markets with downstream entry. The vertical structure is composed of a foreign upstream monopoly supplier selling an essential input to domestic downstream purchasers operating in two different markets, an oligopoly and a monopoly. In the oligopolistic market, a multiproduct firm (being the incumbent) competes with entrants in a Cournot fashion. In the monopoly market, the incumbent sells a different product in its own market. The upstream supplier has the options of choosing between a discriminatory input pricing and a uniform input pricing. We assume that market demand under oligopoly is greater or identical to that under monopoly, the marginal cost of the upstream supplier is zero and all firms in the oligopolistic market have an identical set-up cost.

When the upstream input supplier is a foreign firm and the multiproduct firm and entrants are domestic firms, the upstream input supplier's profit will be excluded from the welfare function. To determine the social optimal number of entrants, the domestic country will maximize the sum of consumer surplus from oligopolistic market and monopoly market and the total net profits of multiproduct firm and entrants. Because more entrants decrease both the output and profit of the multiproduct firm and entrants, these effects create excessive entry in the domestic country whether the input price will be determined by discriminate input pricing or uniform input pricing.

Chapter 3 - Welfare Implications of Downstream Entry When Vertically Integrated Firm Adopts a Non-Foreclosure Strategy

3.1 Introduction

The objective of this paper is to examine how entry into the downstream retail market affects social welfare when a vertically integrated producer (VIP) controls the supply of an essential input to all rival firms producing downstream. Strategically, a VIP can foreclose downstream buyers by setting a sufficiently high input price and making its rivals unprofitable. Nevertheless, a foreclosure strategy eliminates the VIP's sales of its input to downstream buyers and takes out the VIP's profit from the wholesale procedure. This is especially true when the wholesale profit is significantly large and the VIP finds its foreclosure strategy to be unprofitable. We wish to examine the role that the non-foreclosure condition plays in determining the welfare effects of downstream entry, an issue that appears not to have been systematically examined in the industrial economics literature.

It should be noted at the outset that the presence (or absence) of the non-foreclosure condition may affect market equilibrium outcomes under imperfect competition. In an interesting study, Arya, Mittendorf and Sappington (2006) indicate that the foreclosure condition may dramatically reverse the standard conclusions for duopoly. Specifically, the authors find that equilibrium price and industry profit are higher whereas consumer surplus and overall welfare are lower under Bertrand competition than under Cournot competition. Considering the case in which the non-foreclosure condition holds, Chipty (2001) finds that vertical integration is harmless and consumers are better off due to the associated efficiency gains. Given that the non-foreclosure condition exerts a profound impact on social welfare, it is important to know its effect on the social efficiency of downstream entry.

A great deal of studies have devoted to examining the important issues on social efficiency of entry under different conditions. Mankiv and Whinston (1986) show that in a homogenous product market with scale economies and no integer constraint, the business-stealing effect of free entry leads to an excessive number of firms from the social welfare perspective. Ghosh and Saha (2005) show that in the absence of scale economies and the cost asymmetry, free entry can be socially excessive. Mukherjee (2011) shows excessive entry under the absence of scale economies, which is consistent with the finding of Ghosh and Saha (2005). But Mukherjee (2011) indicates that the exogenous cost symmetry is responsible for this result instead of cost asymmetry. Broll and Mukherjee (2009) analyze the welfare effect of entry under the conditions without scale economies but with production cost differences between the firms. The authors find that entry can be socially insufficient if the input market is intensified. But if entrants display inefficiency in production costs and the input market is not intensified, entry is socially excessive. The recent contribution by Mukherjee (2012) further demonstrates that under Stackelberg competition without scale economies, entry is always socially insufficient. But for conditions under which there are scale economies and the difference in marginal costs of production between the leader and its followers is sufficiently large, entry continues to be socially insufficient.

From a different angle, we examine issues on the social efficiency of entry in a vertical market structure where a vertically integrated producer adopts a non-foreclosure strategy. For analyzing the social efficiency of entry when the non-foreclosure condition holds, it is necessary to consider the situation where the marginal cost of the VIP is higher than that of the entrant firms in the downstream market. For a homogeneous product case where there are scale economies and marginal cost difference between the VIP and its retail competitors in a close economy, we show that downstream entry is socially insufficient. We further analyze the case of an open economy in which the VIP is a foreign firm. We find that downstream continues to be socially insufficient. The use of a production subsidy to domestic retail firms in the downstream market is shown to encourage entry and increase domestic welfare.

The remainder of this chapter is organized as follows. Section 3.2 first describes the model of a vertically integrated producer and its rival competitors in the downstream retail market. We then focus our analysis on welfare implications of downstream entry when the VIP adopts a non-foreclose strategy. Section 3.3 analyzes the case when the VIP is a foreign firm and policy options for affecting downstream entry. Section 3.4 concludes.

3.2 The Model

We consider a simple market structure composed of a vertically integrated producer (VIP) and its downstream retail competitors. The VIP is a monopoly in supplying an essential input for its own retail production, as well as for its competitors producing downstream. For the easiness of illustration, we assume that one unit of retail output requires one unit of the essential input and that the VIP's cost of producing the input is zero. Denote $w(>0)$ as the input price that the VIP charges to each buyer. We further assume that the marginal costs of producing the retail output for the VIP and each competitor are c_{VIP} and c_i, respectively. As we wish to study the effect of non-foreclosure on social efficiency of entry, we assume that $c_{VIP} > c_i$, where c_i is zero for simplicity. All firms in the downstream output market incur a set-up cost, denoted as

$k(>0)$. Also, we impose the assumption of symmetry that the VIP's retail competitors are identical in all aspects.

In our analysis, there is a homogeneous good produced by all firms in the downstream market. Market demand for the product is taken to be linear: $P = \alpha - q_{VIP} - \sum_{i=1}^{n} q_i$, where P is market price, and q_{VIP} and q_i are the quantities of the retail good produced by the VIP and the i^{th} firm, respectively, and α is a positive parameter. It is easy to verify that consumer surplus is given as $CS = (q_{VIP} + \sum_{i=1}^{n} q_i)^2 / 2$.

The timing of the two-stage game is as follows. At stage one, the VIP determines an optimal input price for its retail competitors in the downstream market. At stage two, the VIP and the retail firms engage in Cournot competition by choosing the quantities of retail outputs simultaneously and independently. As standard in game theory, we use backward induction to solve for the sub-game perfect Nash equilibrium for the two-stage game.

We begin with the second stage of the game to determine retail outputs produced by firms in the downstream market. Given input price w, the VIP decides on retail output q_{VIP} to maximize its total profit, assuming that all the retail rivals do not change their output decisions. The profit maximization problem of the VIP is:

$$\underset{\{q_{VIP}\}}{Max}\, \pi_{VIP} = \left(\sum_{i=1}^{n} q_i\right) w + \left(\alpha - q_{VIP} - \sum_{i=1}^{n} q_i - c_{VIP}\right) q_{VIP} - k.$$

Similarly, given input price w set by the VIP, each downstream entrant chooses its output q_i to maximize individual profit, assuming that all other firms in the market do not change their output decisions. The profit maximization problem of each entrant is:

$$\max_{\{q_i\}} \ \pi_i = \left(\alpha - q_{VIP} - \sum_{i=1}^{n} q_i - w\right) q_i - k.$$

Solving for the Cournot outputs of the ith entrant and the VIP, we have

$$q_{VIP} = \frac{\alpha + nw - c_{VIP}(n+1)}{n+2} \text{ and } q_i = \frac{\alpha - 2w + c_{VIP}}{n+2}. \tag{1}$$

The total quantity of the input demanded is calculated as

$$X_T = \frac{\alpha(n+1) - c_{VIP} - nw}{n+2}. \tag{2}$$

Substituting q_i and q_{VIP} from (1) into the (inverse) demand function yields the market price:

$$P = \frac{\alpha + c_{VIP} + nw}{n+2}. \tag{3}$$

At the first stage of the two-stage game, the VIP firm decides on an optimal input price that maximizes its total profit. This profit function is given as $\pi_{VIP} = nwq_i + (P - c_{VIP})q_{VIP} - k$, where q_{VIP}, q_i, and P are given in (1) and (3). Solving for the optimal input price yields

$$w^* = \frac{\alpha(n+4) - nc_{VIP}}{2n+8}. \tag{4}$$

Making use of (1)-(4), we calculate the equilibrium outputs of the VIP and the ith entrant (i = 1, …, n):

$$q_{VIP}^* = \frac{\alpha(n+4) - c_{VIP}(3n+4)}{2(n+4)} \text{ and } q_i^* = \frac{2c_{VIP}}{n+4}. \tag{5}$$

We further calculate the equilibrium amount of the input as

$$X_T^* = \frac{\alpha(n+4) + c_{VIP}(n-4)}{2(n+4)}. \tag{6}$$

Following from (5) and (6), we have the comparative statics of downstream entry:

$$\frac{\partial q_{VIP}^{*}}{\partial n} = -\frac{4c_{VIP}}{\left(n+4\right)^{2}} < 0 \text{ and } \frac{\partial X_{T}^{*}}{\partial n} = \frac{4c_{VIP}}{\left(n+4\right)^{2}} > 0 \tag{7a}$$

$$\frac{\partial q_{i}^{*}}{\partial n} = -\frac{2c_{VIP}}{\left(n+4\right)^{2}} < 0. \tag{7b}$$

Equations in (7a) indicate that entry lowers the retail output sold by the VIP but raises the total amount of the input sold to the downstream rivals. Equation (7b) indicates that entry reduces retail output of each entrant.

The net equilibrium profits of the VIP firm and the i[th] entrant are, respectively, given as:

$$\pi_{VIP}^{*} = \frac{\alpha^{2}\left(n+4\right)+c_{VIP}^{2}\left(5n+4\right)-\alpha c_{VIP}\left(2n+8\right)}{4\left(n+4\right)} - k \tag{8a}$$

and

$$\pi_{i}^{*} = \frac{4c_{VIP}^{2}}{\left(n+4\right)^{2}} - k. \tag{8b}$$

Next, we show how downstream entry affects social welfare by comparing the equilibrium number of entrants under market conditions, denoted as n^{*}, to the one determined by the social planner, denoted as $\tilde{n}$. If n^{*} equals $\tilde{n}$, entry is socially optimal; if n^{*} exceeds $\tilde{n}$, entry is excessive; but if n^{*} falls short of $\tilde{n}$, entry is insufficient. We first determine the optimal number of entrants under market conditions. It follows from (8b) that the zero-profit condition is

$$\pi_{i}^{*} = \frac{4c_{VIP}^{2}}{\left(n+4\right)^{2}} - k = 0 \tag{9a}$$

which implies that

$$n^{*} = \frac{2c_{VIP}}{\sqrt{k}} - 4. \tag{9b}$$

To determine the socially optimal number of entrants, we assume that the objective of the social planner is to maximize overall welfare. This social welfare (SW) function is taken to be the sum of the VIP's total profit, the profits of the entrants, and consumer surplus in the downstream market.

The social planner solves the following welfare maximization problem:

$$\underset{\{\tilde{n}\}}{Max}\ \text{SW} = \pi_{VIP}^{*} + n\pi_{i}^{*} + CS^{*},$$

where π_{VIP}^{*} and π_{i}^{*} are given by (8a) and (8b), respectively, and $CS^{*} = (q_{VIP}^{*} + nq_{i}^{*})^{2}/2.$[6] The following expression determines the socially optimal number of entrants $(\tilde{n})$:

$$\frac{2c_{VIP}(\alpha(\tilde{n}+4)+c_{VIP}(\tilde{n}+12))}{(\tilde{n}+4)^{3}} - k = 0. \tag{10a}$$

Evaluating the left-hand side of equation (10a) at the point where $n = n^{*}$ and subtracting from the resulting expression the zero-profit condition in (10a), we have

$$z \equiv \frac{2c_{VIP}(\alpha(n^{*}+4)+c_{VIP}(n^{*}+12))}{(n^{*}+4)^{3}} - \frac{4c_{VIP}^{2}}{(n^{*}+4)^{2}}, \tag{10b}$$

which is strictly positive.

The effect of the marginal cost difference on the value of z is shown by the derivative:

$$\frac{\partial z}{\partial c_{VIP}} = \frac{2\left[\alpha(n^{*}+4)-2c_{VIP}(n^{*}-4)\right]}{(n^{*}+4)^{3}} > 0. \tag{10c}$$

Equation (10b) indicates that the equilibrium number of entrants under market conditions is less than the optimal number of the entrants from the social welfare perspective. That is, $n^{*} < \hat{n}$. This is due to the strict concavity of the profit functions. Equation (10c) indicates that the

[6] Note that q_{VIP}^{*} and q_{i}^{*} are given in (5).

marginal cost difference between the VIP and its retail rivals has a role in affecting the insufficient entry.

We thus have

PROPOSITION 1. *In the case of a vertically integrated producer without foreclosure but with scale economies and marginal cost differentials between the VIP and its retail competitors, entry into the downstream market is socially insufficient.*

The intuition for the proposition 1 is as follows. When the non-foreclosure condition holds, entry results in both the business-creating effect and the business-stealing effect. For the VIP firm, if the number of entrant firms increases, it reduces the outputs of the VIP firm but increases the total input sold in the downstream market. As a consequence, when the number of entrant firms increases, the total profits of the VIP firm will increase. For the retail competitors, if the number of entrants increases, the outputs and profits of the entrant firms will be decreased. Hence, for the entrant firm entry will create the business-stealing effect. As the marginal cost difference between the VIP firm and the entrant firms increases, the strength of the business-creating effect increases.

Proposition 1 indicates that entry is socially insufficient in the presence of scale economies and the marginal cost difference between the VIP and its retail competitors. This is because the business-stealing effect is dominated by the business-creating effect. And the strength of the business-creating effect will depend on the marginal cost different between the VIP firm and the entrant firms. If the marginal cost difference between the VIP firm and entrant firm increases, the strength of the business-creating effect increases, thus resulting in insufficient entry.

3.3 Downstream Entry When the VIP is a Foreign Firm

In this section, we examine welfare implications of downstream entry for an open economy where the VIP is a foreign business entity while its retail competitors are domestic firms. That is, all the entrant firms into the downstream market are from the domestic country. Despite this, equilibrium outputs of the foreign VIP and the domestic retail firms, as well as the optimal number of entrants under market conditions, all remain unchanged.

But the socially optimal number of the domestic retail firms differs due to changes in the social welfare function. The total profit of the foreign VIP is excluded from the domestic welfare, which is the sum of the profits of domestic retail firms and consumer surplus. The welfare maximization problem of the social planner in the open economy case with the VIP as the foreign business entity is:

$$\underset{\{\hat{n}\}}{Max}\ \mathrm{SW}^{\mathrm{OP}} = n\pi_i^* + CS^*,$$

where π_i^* is given by (8b) and $CS^* = (q_{VIP}^* + nq_i^*)^2/2$.

The following expression determines the socially optimal number of entrants $(\hat{n})$:

$$\frac{2c_{VIP}\left[\alpha(\hat{n}+4) - c_{VIP}(\hat{n}-4)\right]}{(\hat{n}+4)^3} - k = 0. \tag{11a}$$

Evaluating the left-hand side of equation (11a) at the point where $n = n^*$ and subtracting from the resulting expression the zero-profit condition in (9a), we have

$$y \equiv \frac{2c_{VIP}\left[\alpha(n^*+4) - c_{VIP}(n^*-4)\right]}{(n^*+4)^3} - \frac{4c_{VIP}^2}{(n^*+4)^2}, \tag{11b}$$

which is strictly positive. The effect of the marginal cost difference on the value of y is shown by the derivative:

$$\frac{\partial y}{\partial c_{VIP}} = \frac{2\left[\alpha\left(n^{*}+4\right)-2c_{VIP}\left(3n^{*}+4\right)\right]}{\left(n^{*}+4\right)^{3}} > 0. \tag{11c}$$

Equation (11b) indicates that the equilibrium number of entrants under market conditions is less than the socially optimal number of the entrants in the open economy with the VIP as the foreign firm. That is, $n^{*} < \hat{n}.$ Equation (11c) indicates that the marginal cost difference between the VIP and its retail competitors also plays a role in affecting the insufficient entry.

The results of the analyses allow us to establish the following proposition:

PROPOSITION 2. *For the case of a vertically integrated producer without foreclosure but with scale economies and marginal cost differences between the VIP and its retail competitors, if the VIP is a foreign firm in an open economy, downstream entry continues to be socially insufficient.*

The intuition for the proposition 2 is as follows. Because the VIP firm's profit are not included in domestic welfare and entrant firms increase the inputs of the VIP firm and also increase the total outputs sold in the downstream market as a consequence the consumer surplus increases. Both of these effects create insufficient entry of entrant firms in domestic country because the business-creating effect dominates the business-stealing effect and the strength of the business-creating effect will be increased if the marginal cost difference of the VIP firm and entrant firms increases.

As entry into the downstream market is socially insufficient in the vertical market structure we consider, it is instructive to see if there are measures that can use to increase the number of entrants in the downstream retail market. One policy option that the social planner may consider for encouraging downstream entry is production subsidy. In the subsequent analysis, we focus on a three-stage game in which the social planner decides on subsidy for each unit of output (denoted as *s*) that maximizes social welfare at the first stage of the game. In the second stage of the game, the VIP determines an optimal input price that maximizes its total profit. In the third and last stage of the game, the VIP and its retail competitors engage in Cournot output competition. As in the previous analysis, we use backward induction to solve for the sub-game perfect Nash equilibrium for the three-stage game.

Given the unit production subsidy s and the input price w, the VIP decides on retail output q_{VIP} in order to maximize its total profit, assuming that all other firms do not change their output decisions. The VIP's profit maximization problem is:

$$\underset{\{q_{VIP}\}}{Max}\,\pi_{VIP} = \left(\sum_{i=1}^{n} q_i\right) w + \left(\alpha - q_{VIP} - \sum_{i=1}^{n} q_i - c_{VIP}\right) q_{VIP} - k.$$

Similarly, given s and w, the i[th] entrant chooses its retail output q_i to maximize its total profit, assuming that all other retail firms and the VIP do not change their output decisions.

The profit maximization problem of the i[th] entrant is:

$$\underset{\{q_i\}}{Max}\ \pi_i = \left(\alpha - q_{VIP} - \sum_{i=1}^{n} q_i + s - w\right) q_i - k.$$

Cournot competition implies that the outputs of the i[th] entrant and the VIP are:

$$q_i = \frac{\alpha + 2s - 2w + c_{VIP}}{n+2} \quad \text{and} \quad q_{VIP} = \frac{\alpha + nw - ns - c_{VIP}(n+1)}{n+2}. \tag{12}$$

Substituting outputs in (12) into the (inverse) demand function yields the market price:

$$P = \frac{\alpha + c_{VIP} + nw - ns}{n+2}. \tag{13}$$

The VIP firm decides on an optimal input price that maximizes its total profit: $\pi_{VIP} = nwq_i + (P - c_{VIP})q_{VIP} - k$, where q_i, q_{VIP}, and P are given in (12)-(13). Solving for the optimal input price yields

$$w^{**} = \frac{\alpha(n+4) + 4s - nc_{VIP}}{2n+8}. \tag{14}$$

Substituting w^{**} in (14) back into (12), we have the equilibrium outputs of the i[th] entrant and the VIP:

$$q_i^{**} = \frac{2\left(c_{VIP} + s\right)}{n+4} \tag{15a}$$

and

$$q_{VIP}^{**} = \frac{\alpha\left(n+4\right) - c_{VIP}\left(3n+4\right) - 2ns}{2\left(n+4\right)}. \tag{15b}$$

The problem of the social planner is to determine an optimal production subsidy for each unit of output that maximizes social welfare. This social welfare function is given as $SW = n\pi_i + CS - nsq_i$, where $\pi_i = (\alpha - q_{VIP} - nq_i + s - w)q_i - k$, $CS = (q_{VIP} + nq_i)^2 / 2$, and w, q_i and q_{VIP} are given in (14)-(15). Solving for the optimal production subsidy rate yields

$$s^{**} = \frac{\alpha\left(n+4\right) - c_{VIP}\left(3n+4\right)}{6n+16}.$$

We thus have

PROPOSITION 3: *In the case of a vertically integrated producer without foreclosure but with scale economies and marginal cost differentials between the VIP and its retail rivals, where the VIP is a foreign firm competing with domestic entrants, one effective way to increase the number of entrants is through the imposition of a production subsidy by the domestic government.*

The intuition for the proposition 3 is as follows. By taking the derivative of social welfare with respect to subsidy the result is positive. This indicates that offering subsidies to entrant firms is welfare improving. In addition, although the subsidy is positive, it is decreasing with the number of downstream entrant and marginal cost of the VIP firm, but increase with the size of downstream market.

3.4 Concluding Remarks

In this paper, we examine welfare implications of downstream entry when an upstream VIP adopts a non-foreclosure strategy. When the VIP firm has sufficiently large wholesale profit, it will not foreclose the entrant firms in downstream market. In the presence of scale economies and the marginal cost difference between the VIP firm and downstream entrants, we show that entry is always socially insufficient. This suggests that entry regulation is not theoretically justified in the downstream market.

In an open economy where the VIP is a foreign firm, downstream entry remains to be socially insufficient. The marginal cost difference between the VIP and the entrants plays a role in influencing the social efficiency of entry. An increase in the marginal cost difference increases the strength of the business-creating effect, which makes it less likely for the foreclosure condition to hold. As a consequence, entry is socially insufficient. To encourage downstream entry, one policy option for the domestic country government is to provide production subsidies to downstream domestic firms. It is shown that a production subsidy policy toward the domestic firms is welfare-enhancing.

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Appendix A - Appendix of Chapter 1

A-1. Proof of Proposition 1

To prove Proposition 1, we make use of profits from (6), (7) and (8), as well as CS^A and CS^B, and SW^{PD} from the following expressions:

$$CS^A = \frac{\left(q_L + nq_i\right)^2}{2} = \frac{\left[\frac{\alpha_A(5n+6)-2\alpha_B(1+n)}{4(3n+4)} + n\frac{\alpha_A}{4(n+1)}\right]^2}{2} = \frac{\left[\alpha_A\left(8n^2+15n+6\right)-\alpha_B\left(2n^2+4n+2\right)\right]^2}{32(3n+4)^2(n+1)^2}$$

$$CS^B = \frac{\left(y_L\right)^2}{2} = \frac{\left[\frac{\alpha_B(5n+6)-2\alpha_A(1+n)}{4(3n+4)}\right]^2}{2} = \frac{\left[\alpha_A(2n+2)-\alpha_B(5n+6)\right]^2}{32(3n+4)^2}$$

$$SW^{PD} = \pi_S + \pi_L + n\pi_i + CS^A + CS^B = \frac{\alpha_A^2 a + \alpha_B^2 b - \alpha_A \alpha_B c}{32(3n+4)^2(n+1)^2} - k(n+1) \qquad \text{(A.1)}$$

where

$$a = 124n^4 + 552n^3 + 895n^2 + 620n + 152,$$

$$b = 91n^4 + 418n^3 + 715n^2 + 540n + 152,$$

$$c = 44n^4 + 208n^3 + 364n^2 + 280n + 80.$$

Taking the first-order derivative of the social welfare function SW^{PD} in (A.1) with respect to n yields

$$\frac{\partial SW^{PD}}{\partial n} = \frac{\alpha_A^2 d + \alpha_B^2 e + \alpha_A \alpha_B f}{16g^3} - k$$

where

$$d = 40n^4 + 239n^3 + 522n^2 + 498n + 176,$$

$$e = 10n^4 + 46n^3 + 78n^2 + 58n + 16,$$

$$f = 4n^4 + 12n^3 + 12n^2 + 4n,$$

$$g = 3n^2 + 7n + 4.$$

Substituting the value of k from the zero-profit condition in (9a) yields

$$\frac{\partial SW^{PD}}{\partial n} = \frac{\alpha_A^2 h + \alpha_B^2 j + \alpha_A \alpha_B m}{16(3n+4)^3 (n+1)^3}$$

where

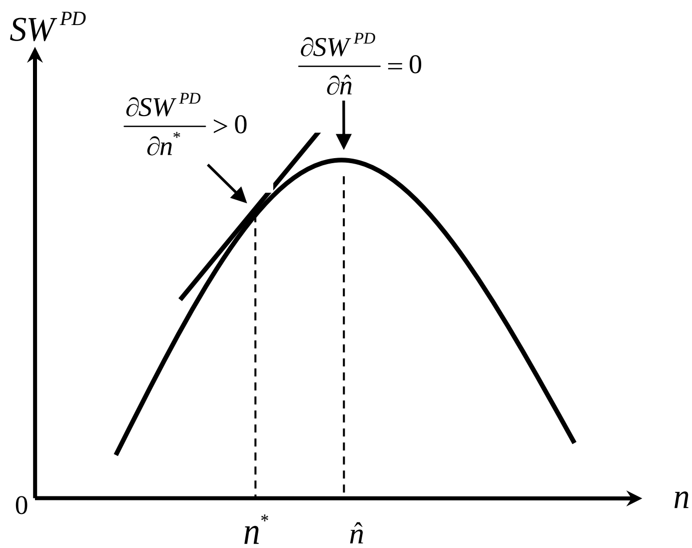
$$h = 13n^4 + 104n^3 + 270n^2 + 290n + 112,$$

$$j = 10n^4 + 46n^3 + 78n^2 + 58n + 16,$$

$$m = 4n^4 + 12n^3 + 12n^2 + 4n.$$

By substituting n^* from (9b), we find that the derivative $\partial SW^{PD} / \partial n$ is unambiguously positive. The strict concavity of the SW^{PD} function implies that $n^* < \hat{n}$ which, in turn, implies that entry is always socially insufficient. This result can be illustrated by Figure A.1.

Figure A.1. **Entry is socially insufficient**



A-2. Proof of Proposition 2

To prove Proposition 2, we make use of profits from (17), (18) and (19), as well as CS^A, CS^B, and SW^{UP} from the following expressions:

$$CS^A = \frac{(q_L + nq_i)^2}{2} = \frac{(2n+1)^2\left[\alpha_A(4n+3)-\alpha_B(n+1)\right]^2}{32(n+1)^2(3n+2)^2}$$

$$CS^B = \frac{(y_L)^2}{2} = \frac{\left(\frac{\alpha_B(5n+3)-\alpha_A(2n+1)}{4(3n+2)}\right)^2}{2} = \frac{\left[\alpha_A(2n+1)-\alpha_B(5n+3)\right]^2}{32(3n+2)^2}$$

$$SW^{UP} = \pi_S + \pi_L + n\pi_i + CS^A + CS^B = \frac{\alpha_A^2 p + \alpha_B^2 q - \alpha_A \alpha_B r}{32(n+1)^2(3n+2)^2} - k(n+1) \quad \text{(A.2)}$$

where

$$p = 124n^4 + 388n^3 + 439n^2 + 214n + 38,$$

$$q = 91n^4 + 300n^3 + 365n^2 + 194n + 38,$$

$$r = 44n^4 + 154n^3 + 194n^2 + 104n + 20.$$

Taking the first-order derivative of the social welfare function SW^{UP} in (A.2) with respect to n yields

$$\frac{\partial SW^{UP}}{\partial n} = \frac{\alpha_A^2 t + \alpha_B^2 u + \alpha_A \alpha_B v}{16w} - k$$

where

$$t = 38n^4 + 149n^3 + 201n^2 + 115n + 24,$$

$$u = 5n^4 + 19n^3 + 27n^2 + 17n + 4,$$

$$v = 11n^4 + 21n^3 + 6n^2 - 8n - 4,$$

$$w = 3n^2 + 5n + 2.$$

Substituting k from zero profit condition (20a) yields

$$\frac{\partial SW^{UP}}{\partial n} = \frac{\alpha_B^2 x - \alpha_A^2 y + \alpha_A \alpha_B z}{16(n+1)^3 (3n+2)}$$

where

$$x = 12n^2 + 8n^3 + 2n^4 + 2 + 8n,$$

$$y = -22n^2 + 3n^3 + 10n^4 - 6 - 22n,$$

$$z = 8 + 50n + 110n^2 + 103n^3 + 35n^4.$$

By substituting n^{**} from (20b), we find that the derivative $\partial SW^{UP} / \partial n$ is unambiguously greater than zero. The strict concavity of the SW^{UP} function implies that $n^{**} < \tilde{n}$ which, in turn, implies that entry is always socially insufficient.

Appendix B - Appendix of Chapter 2

B-1. Proof of Equation 7

Using profits from (4b) and (4c) and CS^A and CS^B from the following expression,

$$CS^A = \frac{\left(q_A + nq_i\right)^2}{2} = \frac{\left[\frac{\alpha_A(n+6)-\alpha_B(n+2)}{8(n+2)} + n\frac{\alpha_A}{2(n+2)}\right]^2}{2} = \frac{\left[\alpha_A(5n+6)-\alpha_B(n+2)\right]^2}{128(n+2)^2},$$

$$CS^B = \frac{(y_l)^2}{2} = \frac{\left(\frac{3\alpha_B-\alpha_A}{8}\right)^2}{2} = \frac{(\alpha_A-3\alpha_B)^2}{128}.$$

We calculate social welfare under input price discrimination as

$$SW^{PD} = \pi_A^{PD} + n\pi_i^{PD} + CS^A + CS^B$$

$$= \frac{\alpha_A^2(15n^2+64n+60)+\alpha_B^2(15n^2+60n+60)-\alpha_A\alpha_B(16n^2+68n+72)}{64(n+2)^2} - k(n+1).$$

Then taking derivative SW^{PD} with respect to n yields,

$$\frac{\partial SW^{PD}}{\partial n} = \frac{\alpha_A(2\alpha_A+2\alpha_B-n\alpha_A+n\alpha_B)}{16(n+2)^3} - k = 0.$$

Plug in k from (5a) yields,

$$\frac{\partial SW^{PD}}{\partial n} = -\frac{\alpha_A\left(\alpha_A(5n+6)-\alpha_B(n+2)\right)}{16(n+2)^3} < 0$$

B-2. Proof of Equation 14

Using profits from (11b) and (11c) and CS^A and CS^B from the following expression,

$$CS^A = \frac{\left(q_A + nq_i\right)^2}{2} = \frac{\left[\left(\frac{\alpha_A(4n+6)-\alpha_B(n+2)}{2(3n+4)(n+2)}\right) + n\left(\frac{2\alpha_A(2n+3)-\alpha_B(n+2)}{2(3n+4)(n+2)}\right)\right]^2}{2}$$

$$= \frac{(n+1)^2\left(\alpha_A(4n+6)-\alpha_B(n+2)\right)^2}{8(n+2)^2(3n+4)^2},$$

$$CS^B = \frac{(y_A)^2}{2} = \frac{\left[\frac{\alpha_B(5n+6)-2\alpha_A(n+1)}{4(3n+4)}\right]^2}{2} = \frac{\left[2\alpha_A(n+1)-\alpha_B(5n+6)\right]^2}{32(3n+4)^2}.$$

We calculate social welfare under uniform input pricing as

$$SW^{UP} = \pi_A^{UP} + n\pi_i^{UP} + CS^A + CS^B = \frac{a\alpha_A^2 + b\alpha_B^2 - c\alpha_A\alpha_B}{32(n+2)^2(3n+4)^2} - k(n+1),$$

where

$$a = 76n^4 + 520n^3 + 1260n^2 + 1296n + 480,$$

$$b = 79n^4 + 512n^3 + 1220n^2 + 1264n + 480,$$

$$c = 92n^4 + 612n^3 + 1480n^2 + 1536n + 576.$$

Then taking derivative SW^{UP} with respect to n yields,

$$\frac{\partial SW^{UP}}{\partial n} = \frac{d\alpha_A^2 + e\alpha_B^2 - f\alpha_A\alpha_B}{8(3n^2+10n+8)^3} - k = 0$$

where

$$d = -10n^4 + 18n^3 + 204n^2 + 360n + 192,$$

$$e = 11n^4 + 82n^3 + 228n^2 + 280n + 128$$

$$f = n^4 + 46n^3 + 216n^2 + 352n + 192 + 576.$$

By plugging k from (12a) yields,

$$\frac{\partial SW^{UP}}{\partial n} = -\frac{g\alpha_A^2 - h\alpha_B^2 - j\alpha_A\alpha_B}{8(n+2)^3(3n+4)^3} < 0 \text{ if } \alpha_A > \alpha_B,$$

where

$$g = 106n^4 + 590n^3 + 1228n^2 + 1128n + 384,$$

$$h = 5n^4 + 38n^3 + 108n^2 + 136n + 64,$$

$$j = 47n^4 + 282n^3 + 616n^2 + 576n + 192.$$

Appendix C - Appendix of Chapter 3

C-1. Proof of Proposition 1

Making use of firm profits in (8a) and (8b) and consumer surplus from the following expression:

$$CS^* = \frac{1}{2}(q_{VIP}^* + nq_i^*)^2 = \frac{1}{2}\left[\frac{\alpha(n+4)-c_{VIP}(3n+4)}{2(n+4)} + n\frac{2c_{VIP}}{n+4}\right]^2 = \frac{[4(\alpha-c_{VIP})+n(\alpha+c_{VIP})]^2}{8(n+4)^2},$$

we calculate social welfare to be

$$SW = \pi_{VIP}^* + n\pi_i^* + CS^*$$
$$= \frac{\alpha^2(3n^2+24n\alpha^2+48\alpha^2)+c_{VIP}^2(11n^2+72n+48)-\alpha c_{VIP}(2n^2+32n+96)}{8(n+4)^2} - (n+1)k.$$

The slope of the social welfare function is:

$$\frac{\partial SW}{\partial n} = \frac{2c_{VIP}[\alpha(n+4)+c_{VIP}(n+12)]}{(n+4)^3} - k.$$

Evaluating this slope at the point where $n = n^*$ and substituting the zero-profit condition under market conditions in (9a), we have

$$\frac{\partial SW}{\partial n} = \frac{2c_{VIP}[\alpha(n^*+4)-c_{VIP}(n^*-4)]}{(n^*+4)^3} > 0,$$

which is strictly positive. The strict concavity of the social welfare function implies that $n^* < \tilde{n}$. Thus, under market conditions, entry is socially insufficient. Further, taking the derivative of $\partial SW/\partial n$ with respect to c_{VIP} yields

$$\frac{\partial}{\partial c_{VIP}}\left(\frac{\partial SW}{\partial n}\right) = \frac{2[\alpha(n^*+4) - 2c_{VIP}(n^*-4)]}{(n^*+4)^3} > 0.$$

This indicates that if the marginal cost difference between the VIP and entrants increases, the strength of the business-creating effect increases, creating a greater degree of insufficient entry.

C-2. Proof of Proposition 2

Using π_i^* from (8b) and CS^* from A-1, we calculate SW^{OP} as follows:

$$SW^{OP} = n\pi_i^* + CS^* = \frac{\alpha^2(n^2+8n+16) + c_{VIP}^2(n^2+24n+16) + \alpha c_{VIP}(2n^2-32)}{8(n+4)^2} - nk.$$

Taking the derivative of SW^{OP} with respect to n yields

$$\frac{\partial SW^{OP}}{\partial n} = \frac{2c_{VIP}[\alpha(n+4) - c_{VIP}(n-4)]}{(n+4)^3} - k.$$

Evaluating this slope at the point where $n = n^*$ and substituting the zero-profit condition under market conditions in (9a), we have

$$\frac{\partial SW^{OP}}{\partial n} = \frac{2c_{VIP}[\alpha(n^* + 4) - 2c_{VIP}(3n^* + 4)]}{(n^* + 4)^3} > 0,$$

which is strictly positive. The strict concavity of the social welfare function implies that $n^* < \hat{n}$. Thus, under market conditions, entry is socially insufficient. Further, taking the derivative of $\partial SW^{OP} / \partial n$ with respect to c_{VIP} yields

$$\frac{\partial}{\partial c_{VIP}}\left(\frac{\partial SW^{OP}}{\partial n}\right) = \frac{2[\alpha(n^* + 4) - 2c_{VIP}(3n^* + 4)]}{(n^* + 4)^3} > 0.$$

For the case of an open economy, if the marginal cost difference between the VIP and entrants increases, the strength of the business-creating effect increases, creating a greater degree of insufficient entry.

C-3. Proof of Proposition 3

Making use of firm profits in the open economy case with production subsidies and consumer surplus from the following expression,

$$CS = \frac{1}{2}(q_{VIP}^{**} + nq_i^*)^2 = \frac{1}{2}\left[\frac{\alpha(n+4) - c_{VIP}(3n+4) - 2ns}{2(n+4)} + n\frac{2(c_{VIP} + s)}{n+4}\right]^2 = \frac{\left[\alpha(n+4) + c_{VIP}(n-4) + 2ns\right]^2}{8(n+4)^2},$$

we calculate the social welfare function:

$$SW^{OP} = n\pi_i + CS$$

$$= \frac{\alpha^2\left(n^2+8n+16\right)+c_{VIP}^2\left(n^2+24n+16\right)-k\left(8n^3+64n^2+128n\right)-s^2\left(12n^2+32n\right)+\alpha c_{VIP}\left(2n^2-32\right)+s\alpha\left(4n^2+16n\right)-sc_{VIP}\left(12n^2+16n\right)}{8\left(n+4\right)^2}$$

Taking the derivative of SW^{OP} with respect to s and setting the resulting expression to zero, we solve for the optimal production subsidy rate:

$$s^{**} = \frac{\alpha\left(n+4\right)-c_{VIP}\left(3n+4\right)}{6n+16}.$$