EFFECTS OF SCALE ECONOMY ON MERGER PROFITABILITY AND EFFICIENCY

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Abstract

This thesis characterizes how a merger's profitability and efficiency are affected by its size and by its scale economy factor d in a Cournot market with linear demand and quadratic costs. Our results allow us to challenge the widely believed view among economists that mergers typically are not profitable for the insiders (merged firms). In contrast to the minimum of 80% pre-merger market share required for the insiders to be profitable in Salant, Switzer and Reynolds (1983), our model shows that mergers with much less market share are also profitable. It is worth noting that in the market with diseconomies of scale (i.e., $d > 0$), any two-firm merger could be profitable as long as its scale economy factor is greater than the critical value d_2^*, which is solely determined by the market size n. Our results also allow us to provide useful implications for antitrust laws especially the horizontal merger policy. In our model, mergers with economies of scale (i.e., $-2 < d \leq 0$) and with more than 50% combined pre-merger market share are beneficial to both public interest and merging firms. This observation implies that even monopolies in this market could contribute positively to social welfare. This result is different from what Farrell and Shapiro (1990) and Levin (1990) have obtained in their papers that only mergers with less than 50% pre-merger market share are both profitable and efficient. Although mergers generally raise price, we find that mergers can also lower price and expand output if and only if they enjoy substantial economies of scale.

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To my husband and my parents

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Chapter 1

Introduction

There has been substantial research on how a horizontal merger affects the merging firms' joint profits and social efficiency. Those studies show that in their quantity-setting games, mergers are not typically beneficial to the insiders unless they involve the vast majority of the industry participants. Furthermore, it is argued that profitable mergers are not welfare-enhancing if the insiders' aggregate pre-merger share is greater than 50% of the market share. The belief that mergers formed by a small subset of firms are typically not profitable is popular among economists. In addition, it is commonly believed that mergers that substantially increase the market concentration are detrimental to the public interest and should therefore be disapproved by the antitrust authorities.

In this thesis, we provide a model for horizontal mergers that generate appealing results for both merging firms and society. In particular, we provide a Cournot model in which mergers, even if formed by a small subset of firms, are beneficial to the insiders and social welfare. Moreover, in our model, even monopolies could be both profitable and welfare-enhancing. Thus, our model yields outcomes that are significantly different from those already obtained in previous work.

It is necessary to provide an overview of previous literature on horizontal mergers. The argument on a horizontal merger's effects on the insiders' profitability was triggered by Salant, Switzer, and Reynolds (1983) (henceforth, SSR). They apply a linear symmetric Cournot model with identical and constant marginal costs, which is viewed as a fundamental model with basic features for horizontal merger analysis. They assume that the merging firms will continue to operate like Cournot players following the merger, and the rest of the firms in the market remain independent. In their model, no direct cost savings arise as a consequence of the merger, and the post-merger market remains symmetric. They find that the insiders must have at least 80% joint pre-merger market share for a merger to be profitable. No explicit discussion on welfare effect is provided in SSR. However, since efficiency analysis is an important part of this thesis, we refer, next, to some articles on mergers' welfare effects.

Work by Levin (1990) applies a Cournot model with non-linear demand and asymmetric marginal costs. It is assumed that the merging group does not need to remain as a Cournot player after the merger. The most important finding of Levin's paper is that a merger will increase social welfare if it is profitable and its combined pre-merger market share is no more than 50% of the market share (this condition is called 50% benchmark). Similar results are obtained in Farrell and Shapiro (1990), in which they apply a Cournot model with general demand and general costs. They find that a profitable merger would be welfare-enhancing if the insiders' aggregate market share is less than the weighted sum of the outsiders' combined market share. This condition is equivalent to the 50% benchmark when the general cost functions are set to be linear.

In a recent paper, Heubeck, Smythe and Zhao (2003) (henceforth, HSZ) study the conditions under which a merger would be profitable and welfare-enhancing in a linear Cournot Oligopoly model with asymmetric costs. They find that the cost differential between efficient and inefficient firms plays a key role in determining the likelihood of profitability and efficiency of a merger. The greater the cost differential, the smaller the minimum combined pre-merger market share required for profitable mergers. Therefore, in HSZ's paper, mergers formed by small subsets of firms are profitable due to the cost asymmetry among firms. In terms of the welfare effects, the authors illustrate that mergers with more than 50% pre-merger market share could also be profitable and welfare-enhancing. Therefore, their set of profitable and efficient mergers is much larger than the one defined by the 50% benchmark. This difference can be attributed to the cost differentials in HSZ's model.

The model proposed in this thesis is an extension of SSR's model. The key difference between our model and theirs is that we apply quadratic costs instead of linear costs for each individual firm. In our Cournot model with linear demand and quadratic costs, we examine how a horizontal merger's profitability and efficiency are affected by its size and by its scale economy factor d. Conditions required for mergers to be profitable and efficient are characterized. One particular point that we emphasize is that, although the effects of a merger's size on its profitability and efficiency have been studied, the effects of the scale economy factor d on a horizontal merger's profitability and efficiency have not, as far as we know, been studied yet. As we will see, the scale economy factor plays a key role in determining the conditions required for a merger to be profitable and welfare-enhancing. In other words, one of the purposes of this thesis is to evaluate the effects of scale economy factor on horizontal mergers' profitability and efficiency in a Cournot model with linear demand and quadratic costs.

We find that, due to the scale economy factor, the profitable mergers in our model could have much less market share. In particular, when the market is in diseconomies of scale (i.e., $d > 0$), any two-firm merger would be profitable provided its scale economy factor is greater than its critical value. This observation challenges the popular belief held by the vast majority of economists who believe that it is impossible for mergers involving small subsets of firms to be profitable. Finally, we show that there is a positive relationship between the (absolute) value of the scale economy factor and the incentives to merge. In other words, the insiders are more likely to merge as d or the absolute value of d becomes larger.

It has been noticed that since the second half of the 20th century, economic research has had increasing impact on antitrust enforcement. And nowadays, economists have substantial influence in guiding the formation of antitrust policy. The other purpose of this thesis is to provide useful implications in formulating the antitrust laws, especially the horizontal merger policy. Our results on mergers' welfare effects allow us to call for a reconsideration of the traditional view on mergers and the criteria in evaluating the feasibility of a proposed merger.

It is evident that a horizontal merger that occurs among a subset of firms may reduce competition and increase market concentration. The traditional view is that the increase in market concentration is detrimental to the public interest and therefore would most likely be discouraged by the antitrust authorities. For example, in the United States, the Department of Justice and the Federal Trade Commission are the antitrust agencies which evaluate the mergers' likely effect on competition and have the power to authorize or reject merger proposals. In evaluating proposed mergers, antitrust laws are enforced to prohibit mergers that "substantially decrease competition or tend to create a monopoly" (Section 7 of the Clayton Act). Yet, antitrust law is evolving. Now, the antitrust authorities would not evaluate a merger proposal solely based on the market concentration. They pay close attention to the efficiency change caused by the merger. Thus mergers could be approved if they are expected to improve social efficiency even though they reduce competition.

In our more general model, we show that mergers with economies of scale (i.e., $-2 < d \leq 0$) are most likely to be beneficial to society. It is true, although counterintuitive, that even monopolies in this market could enhance public interest. However, we also find mergers that are not beneficial to society. In the market with diseconomies of scale (i.e., $d > 0$), any merger would be harmful to social welfare, even though they might be privately beneficial to the merging firms. From the social efficiency standpoint, mergers with diseconomies of scale are most likely be banned by the antitrust agencies because of their negative effects on social welfare.

Finally, taking into consideration of both profitability and efficiency of mergers, we show that there is a large set of mergers which are both profitable and welfare-enhancing in the market with economies of scale. These mergers usually have more than 50% of joint pre-merger market share. Furthermore, we find that the minimum market share required for profitable and efficient mergers is changing with the market size. In other words, the greater the market size, the larger the critical market share required for mergers to be profitable and welfare-enhancing. It is, however, not the case for mergers with diseconomies of scale.

The rest of the thesis is organized as follows: Chapter 2 characterizes the model, the insiders' post-merger cost functions and the pre-merger market equilibrium; Chapter 3 examines the conditions necessary for profitable mergers; Chapter 4 examines the conditions necessary for welfare-enhancing mergers and; Chapter 5 offers the concluding remarks. The Appendix provides proofs of all propositions and corollaries.

Chapter 2

Problem Description

This thesis studies a Cournot Oligopoly model for a homogeneous good with linear demand and quadratic costs. Our goal is to find out the conditions that must be satisfied for a merger to be profitable and efficient. Our analysis focuses on the effects of the scale economy factor on a merger's profitability and efficiency. In this chapter, we provide our model first, and then demonstrate the post-merger cost functions for the merging firms, followed by a characterization of the per-merger market equilibrium.

2.1 Model Description

We apply a Cournot Oligopoly model with linear demand and quadratic costs for homogeneous goods. The linear (inverse) demand function [1] is defined by $P(\sum q_k) = a - \sum q_k$, where $a > 0$ is the price intercept, and the quadratic cost function for firm j is defined by $C_j(q_j) = cq_j + \frac{d}{2}q_j^2$, $j = 1, \ldots, n$, where $c > 0$ is a parameter, d is the scale economy factor, which could be positive and non-positive, and n is the total number of firms in the market.

From the quadratic cost function, we know that prior to the merger the average and marginal costs for an individual firm are $AC_j(q_j) = c + \frac{d}{2}q_j$ and $MC_j(q_j) = c + dq_j$ respectively. The slope of the marginal cost curve is exactly twice that of the average cost curve. In the presence of negative (positive) d, average cost curve lies above (below) the marginal cost curve and both curves are strictly decreasing (increasing). As a consequence, mergers with negative d have economies of scale, while, mergers with positive d have diseconomies of scale.

Let S denote a merger with m $(2 \leq m \leq n)$ members, then $S = \{1, ..., m\}$. Following Farrell and Shapiro (1990), the post-merger cost function for a merger $S \subset N = \{1, \ldots, n\}$ is given by $C_S(q_S) = Min\{\sum_{i \in S} C_i(q_i) \mid \sum_{i \in S} q_i = q_S, q_i \geq 0, i \in S$, whose properties are studied below.

[1] The general market demand function is $P(\sum q_k) = a - b\sum q_k$. We suppose that the slope is -1, which will have no effect on the results derived in this thesis.

2.2 The Post-merger Cost Functions for the Insiders

In order to precisely characterize the post-merger cost functions, we need to decompose d into $-2 < d \leq 0$ [2] and $d > 0$ and obtain the insiders' post-merger cost functions separately.

Proposition 1. *(i) The post-merger cost function for mergers with economies of scale (i.e., $-2 < d \leq 0$)is given by*

$$C_S(q_S) = cq_S + \frac{d}{2}q_S^2. \tag{2.1}$$

(ii) The post-merger cost function for mergers with diseconomies of scale (i.e., $d > 0$) is given by

$$C_S(q_S) = cq_S + \frac{d}{2m}q_S^2. \tag{2.2}$$

All proofs of the Propositions are in the Appendix. Part (i) of Proposition 1 implies the exit of $(m-1)$ firms in the insiders subsequent to the merger. The average cost of the insiders after merger is given by

$$AC_S(q_S) = c + \frac{d}{2}q_S.$$

Since d is negative, the average cost decreases as insiders' output q_S increases. In other words, the average cost is a decreasing function in output: the more a firm produces, the more it saves in costs. It is, therefore, more efficient to supply q_S by only one firm than by m firms. This indicates that to achieve the minimal cost, $(m-1)$ firms in the insiders are being removed from the market and only one firm remains and produces the total output supplied by the merger. Example 1 shows that in the market with economies of scale, the merging group achieves its minimal cost when only one firm of the merger remains in the market and produces q_S.

Example 1: Consider a five-firm merger in a ten-firm oligopoly (i.e., $m = 5$, $n = 10$). Let $d = -.5$. The cost of q_S, produced by a single firm, is $\overline{C}_S = cq_S - \frac{1}{4}q_S^2$ and the cost of q_S, produced by five firms, is $\overline{\overline{C}}_S = cq_S - \frac{1}{20}q_S^2$ (assume each firm produces $\frac{1}{5}$ of q_S). It is obvious that $\overline{C}_S$ is smaller than $\overline{\overline{C}}_S$. This result also applies to cases when q_S is produced by multiple firms up to four. Therefore, producing q_S by 1 unit is most efficient.

Part (ii) of Proposition 1 implies that m merging firms would continue operating in m units after the merger and no firm is going to be removed from the market. The average cost of the insiders following the merger is given by

$$AC_S(q_S) = c + \frac{d}{2m}q_S.$$

[2]The Second Order Condition for profit maximization requires that d being greater than -2. This condition is shown as $\frac{\partial^2 \pi_j}{\partial q_j^2} < 0 \Leftrightarrow -1 - 1 - d < 0 \Leftrightarrow d > -2$.

Since d is positive, the average cost is an increasing function in output: the more a firm produces, the greater the cost would be. Consequently, to achieve the smallest possible cost for the merger, each merging firm will produce exactly $\frac{1}{m}$ of the insiders' total output. Given the merger's output q_S, each insider firm would supply $\frac{q_S}{m}$ so that the insiders' post-merger cost can be minimized. Example 2 explains this.

Example 2: Suppose $n = 10$,$m = 5$, and $d = 2$. When each merging firm produces $\frac{q_S}{5}$, the total cost for the merger would be $\overline{C}_S = cq_S + \frac{1}{5}q_S^2$. If the merger's output is supplied by a single firm, the total cost for the merger would be $\overline{\overline{C}}_S = cq_S + q_S^2$. Because $\overline{C}_S > \overline{\overline{C}}_S$, it is evident that producing q_S by m units is more efficient. This is also true when q_S is produced by multiple firms less than five.

2.3 The Pre-merger Equilibrium

In order to determine whether a merger would increase/decrease the insiders' profits and social welfare, it is necessary to characterize the pre-merger market. Proposition 2 summarizes the pre-merger market equilibrium, the insiders' pre-merger profits and the pre-merger social welfare.

Proposition 2. *Let q_j^o be the pre-merger equilibrium individual output [3]; π_j^o, P^o, π^o, CS^o, W^o, and π_S^o be the individual firm's profit, equilibrium price, total profit, consumer surplus, social welfare and the sum of insiders' pre-merger profit. Then*

$$q_j^o = \frac{a-c}{n+d+1} for j = 1, ..., n \tag{2.3}$$

$$\pi_j^o = \frac{(2+d)(a-c)^2}{2(n+d+1)^2} for j = 1, ..., n \tag{2.4}$$

$$P^o = \frac{a+ad+cn}{n+d+1} \tag{2.5}$$

$$\pi^o = \frac{n(2+d)(a-c)^2}{2(n+d+1)^2} \tag{2.6}$$

$$CS^o = \frac{n^2(a-c)^2}{2(n+d+1)^2} \tag{2.7}$$

$$W^o = \frac{n(a-c)^2(n+d+2)}{2(n+d+1)^2} \tag{2.8}$$

[3] In equation q_j^o, the numerator $(a-c)$ must be greater than 0. This condition holds when the market is in equilibrium.

$$\pi_S^o = \frac{m(2+d)(a-c)^2}{2(n+d+1)^2}. \tag{2.9}$$

From Proposition 2 we know that in the pre-merger equilibrium, each individual firm has the same amount of output, profits and costs. Thus, the pre-merger market is in symmetry.

Now, we are in a position to explore the features in the post-merger market and the conditions required for a merger to be profitable and welfare-enhancing.

Chapter 3

Merger Profitability

In Chapter 3, we examine the conditions necessary for a merger to be profitable. By profitable, we mean that the post-merger profit of the insiders is greater than their combined pre-merger profit. We will first consider mergers with economies of scale, followed by mergers with diseconomies of scale. Finally, we demonstrate the profitability conditions by putting mergers with economies/diseconomies of scale together.

3.1 Mergers with Economies of Scale

Before examining the profitability conditions, it is necessary to obtain the post-merger market equilibrium, the insiders' post-merger profits and the post-merger social welfare. All of them are presented in Proposition 3.

3.1.1 Post-merger Equilibrium

Proposition 3. *Let P^e be the post-merger equilibrium price; q_S^e, q_j^e, π_S^e, π^e, CS^e and W^e be the insiders' output, outsider's output, insiders' profit, total profit, consumer surplus and social welfare. Then,*

$$P^e = \frac{a(1+d)+(n-m+1)c}{2+d+n-m} \tag{3.1}$$

$$q_S^e = \frac{a-c}{2+d+n-m} \tag{3.2}$$

$$q_j^e = \frac{a-c}{2+d+n-m} for j \notin S \tag{3.3}$$

$$\pi_S^e = \frac{(2+d)(a-c)^2}{2(2+d+n-m)^2} \tag{3.4}$$

$$\pi^e = \frac{(n-m+1)(d+2)(a-c)^2}{2(2+d+n-m)^2} \tag{3.5}$$

$$CS^e = \frac{(1+n-m)^2(a-c)^2}{2(2+d+n-m)^2} \tag{3.6}$$

$$W^e = \frac{(n-m+1)(a-c)^2(3+n-m+d)}{2(2+d+n-m)^2} \tag{3.7}$$

Since the insiders' post-merger cost function is the same as the outsiders', the post-merger market is still symmetric. The difference between the pre-merger and post-merger markets is that in the post-merger market there are only $(n-m+1)$ identical firms, of which one is the merger and the rest are the outsiders. The merger shares $\frac{1}{n-m+1}$ of the market output and profit respectively. The post-merger market equilibrium price and output are different from their pre-merger counterparts as a result of the smaller market size.

By comparing the post-merger and pre-merger markets, we demonstrate changes in market price and insiders' output in Corollary 1.

Corollary 1. *(i) The market price change is given by*

$$P^e - P^o = \frac{(a-c)(m-1)(1+d)}{(2+d+n-m)(n+d+1)}. \tag{3.8}$$

Since the sign of $(1+d)$ *is unknown, the post-merger market price could either rise or fall. When* $-1 < d \leq 0$ $(-2 < d < -1)$, *the merger would raise (lower) price; and when* $d = -1$, *the market price remains unchanged. It follows that market output reduces (increases) when* $-1 < d \leq 0$ *(-2¡d¡-1) and stays the same as* $d = -1$.

(ii) The insiders' output change is given by

$$q_S^e - \sum_{i \in S} q_i^o = -\frac{(a-c)(m-1)(-m+n+d+1)}{(2+d+n-m)(n+d+1)}. \tag{3.9}$$

The output of the merging firms generally decreases following the merger. However, when all firms in the market form a monopoly, their post-merger output either expands or contracts. In correspondence with the market price movement, the monopoly's output decreases (increases) when $-1 < d \leq 0$ $(-2 < d < -1)$ *and stays the same at* $d = -1$.

All proofs of the corollaries are in the Appendix. It is clear from Corollary 1 that a merger can raise output and reduce price only when it obtains substantial economies of scale. Otherwise, mergers usually raise price and thus hurt consumers' benefits.

3.1.2 Profitability Conditions

The insiders' profit change is given by the difference of the post-merger and pre-merger profits:

$$\pi_S^e - \pi_S^o = -\frac{(a-c)^2(d+2)(m-1)(m(m-2d-3-2n)+d(2n+d+2)+(n+1)^2)}{2(2+d+n-m)^2(n+d+1)^2}. \tag{3.10}$$

Proposition 4. *The following four claims are equivalent:*

(i) $\pi_S^e > \pi_S^o$

(ii) $m > m_1^e$

(iii) $-2 < d < Min\{d_1^e, 0\}$

(iv) $\theta > \theta_1^e$,

where m_1^e, d_1^e *and* θ_1^e *are given by*

$m_1^e = \frac{3}{2} + n + d - \frac{1}{2}\sqrt{5 + 4n + 4d}$

$d_1^e = m - 1 - n + \sqrt{m}$

$\theta_1^e = (\frac{m_1^e}{n})$,

which are the critical merger size, critical value of the scale economy factor and critical combined pre-merger market share required for profitable mergers with economies of scale, respectively.

In contrast to the symmetric Cournot model with linear cost, in which a minimum of 80% combined pre-merger market share is necessary for a merger to be profitable. In our model, the quadratic cost makes many smaller mergers profitable. This is demonstrated in Example 3.

Example 3: Consider a market of ten firms, a merger is formed by seven firms in the market, each firm has d being equal to -1.5. The profit change $(\pi_S^e - \pi_S^o)$ equals $1.0176 * 10^{-3}(a-c)^2$, which is positive. Thus a merger of seven firms in this market is profitable. Since all firms are identical prior to the merger, each firm has 10% of the market share. This implies that 70% of the combined pre-merger market share is large enough for profit gains.

Corollary 2 shows that the greater the economies of scale, the smaller the critical merger size required for a merger to be profitable.

Corollary 2. *The partial derivative of* m_1^e *with respective to* d *is given by*

$$\frac{\partial m_1^e}{\partial d} = 1 - (5 + 4n + 4d)^{-\frac{1}{2}} > 0. \tag{3.11}$$

Thus, larger absolute value of economies of scale reduces the minimal market share for a profitable merger.

This result is clearly shown in Example 4 and Figure 3.1.

Example 4: Consider a ten-firm market. Suppose d goes from $d = -.1$ to $d = -1$ and to $d = -1.99$. The corresponding minimum profitable merger sizes are 8.0608, 7.2984 and 6.467. This shows that the greater the economies of scale, the smaller the critical profitable merger size.

Figure 3.1 illustrates the profitability of mergers when $n = 10$. [1] The vertical axis defines the insiders' combined pre-merger market share and the horizontal axis defines the value of the scale economy factor d. This figure is divided into two parts with $d = 0$ as the cutting point. On the

[1]The smaller the number n of firms in the market, the steeper the profit line would be. In general, however, the results are not substantially different for other relevant values of n.

left part of the graph, the scale economy factor takes negative values and it changes from -2 to 0. Thus, mergers locating on this part enjoy economies of scale. The upward sloping line shows the lower boundary of the insiders' pre-merger market share necessary for mergers to be profitable at different levels of d. Mergers lying above the profit line are profitable. It is evident that many mergers with less than 80% market share are profitable since most part of the profit line falls under the 80% mark. It is clear that as firms obtain greater economies of scale (i.e., as d goes from 0 to -2), the critical market share for profitable mergers becomes smaller.

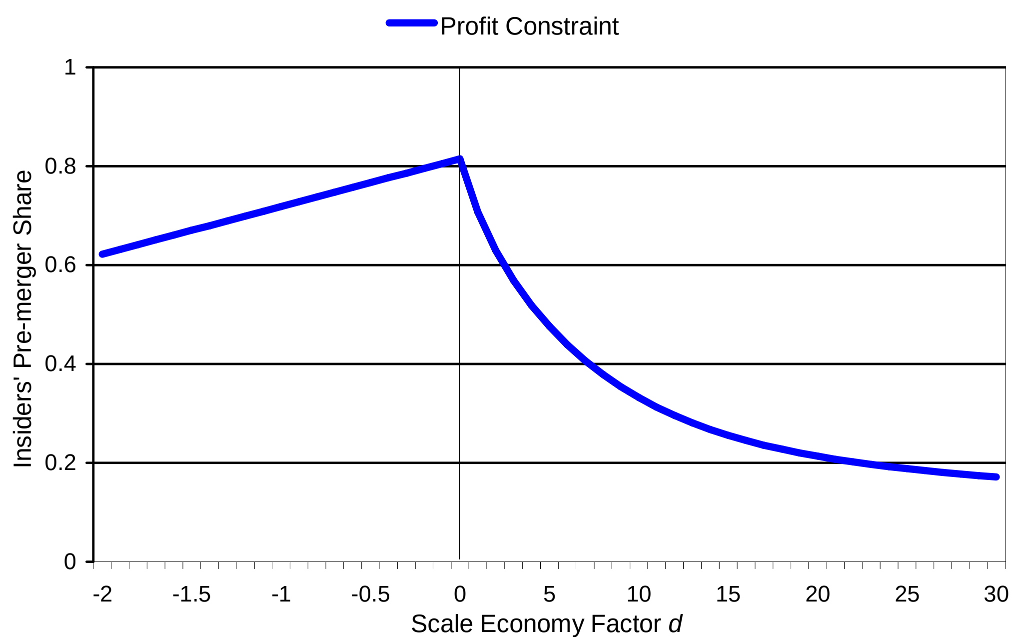

Figure 3.1: Profitability of mergers with economies/diseconomies of scale when $n = 10$. Notes: The set of profitable mergers is included in the area above the profit curve.

Having obtained the insiders' pre-merger and post-merger profits, we are able to draw a three-dimensional graph which illustrates the relationship between the insider's profits, merger size m and the scale economy factor d. In Figure 3.2, the vertical axis defines the insiders' profits and the two horizontal axes define m and d respectively. The flat surface represents the insiders' combined pre-merger profits, the steep one represents the insiders' post-merger profits and their difference represents profit gains/losses.

In Figure 3.2, the steep surface intersects the flat one from below, which illustrates there are mergers that are unprofitable. In other words, the area locating under the steep surface includes all mergers that are not profitable. This result confirms the result obtained in Figure 3.1.

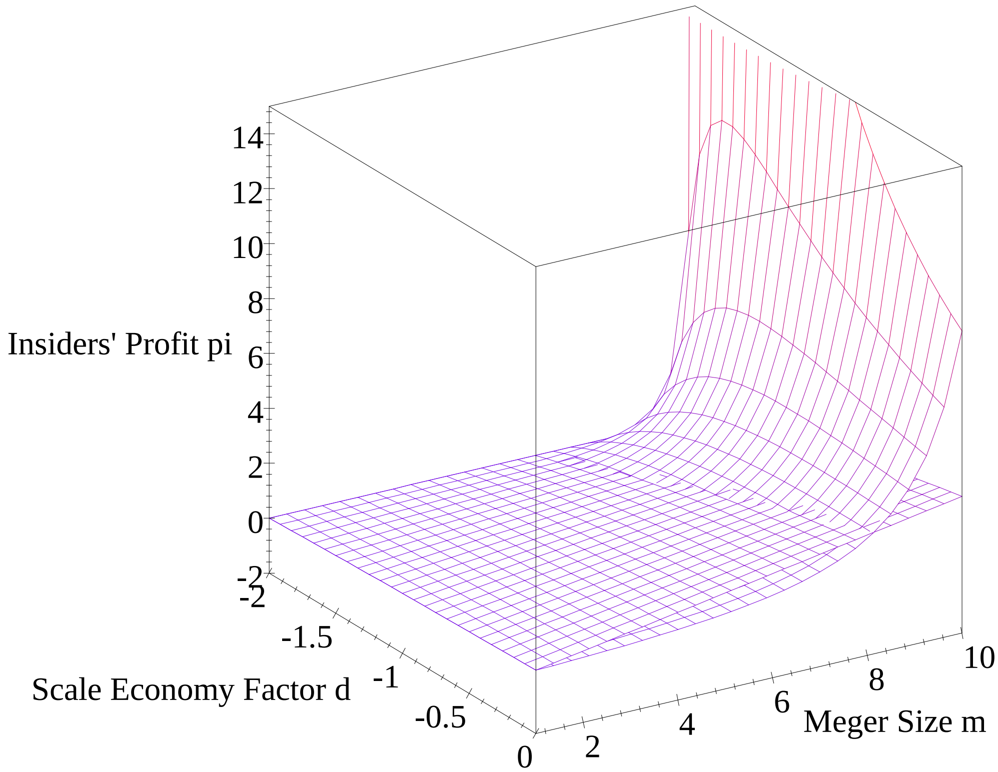

Figure 3.2: Profitability of mergers with economies of scale when $n = 10$ in a three-dimensional graph.

3.2 Mergers with Diseconomies of Scale

In contrast to the post-merger market in the presence of negative d, the post-merger market in the presence of positive d appears to be much different due to the market structure change following the merger.

3.2.1 Post-merger Equilibrium

Similar to the mergers with economies of scale, we present the post-merger market equilibrium, the post-merger profit for mergers with diseconomies of scale and the post-merger social welfare in Proposition 5 before examining the profitability conditions.

Proposition 5. *Let P^* be the post-merger equilibrium price; q_S^*, q_j^*, π_S^*, π_j^*, π^*, CS^* and W^* be the insiders' output, each outsider's output, insiders' profit, each outsider's profit, total profit, consumer surplus and social welfare. Then,*

$$P^* = \frac{a(md + m + d + d^2) + c(m + mn - m^2 + nd)}{md + mn + 2m - m^2 + nd + d + d^2} \tag{3.12}$$

$$q_S^* = \frac{m(a-c)(1+d)}{md+mn+2m-m^2+nd+d+d^2} \tag{3.13}$$

$$q_j^* = \frac{(a-c)(m+d)}{md+mn+2m-m^2+nd+d+d^2} forj \notin S \tag{3.14}$$

$$\pi_S^* = \frac{m(1+d)^2(a-c)^2(2m+d)}{2(md+mn+2m-m^2+nd+d+d^2)^2} \tag{3.15}$$

$$\pi_j^* = \frac{(m+d)^2(a-c)^2(2+d)}{2(md+mn+2m-m^2+nd+d+d^2)^2} forj \notin S \tag{3.16}$$

$$\pi^* = \frac{(a-c)^2((d+2)(nd^2+2nmd-m^3+nm^2)+m(d+2m))}{2(md+mn+2m-m^2+nd+d+d^2)^2} \tag{3.17}$$

$$CS^* = \frac{(a-c)^2(m+mn-m^2+nd)^2}{2(md+mn+2m-m^2+nd+d+d^2)^2} \tag{3.18}$$

$$W^* = \frac{(a-c)^2(nd^2(d+n+2+2m)+md(2n^2+6m-nm+1-m^2)+m^2(n+d-m)(n+1-m))}{2(md+mn+2m-m^2+nd+d+d^2)^2}. \tag{3.19}$$

Since the insiders' post-merger cost function is different from the outsiders', the post-merger market becomes asymmetric. In contrast to their pre-merger output, the insiders' post-merger output always decreases [2] due to the cost-savings they obtain through the merger; however the outsiders' combined output increases following the merger. The output increase by the outsiders is, however, not large enough to offset the output decrease by the insiders, and as a result the total market output decreases. Consumers are hurt by the market change since the consumer surplus goes down as a result of the higher market price and lower market supplies.

By comparing the post-merger and pre-merger markets, we demonstrate changes in market price and output in Corollary 3.

Corollary 3. *(i)The market price change is given by*

$$P^* - P^o = \frac{m(m-1)(d+1)(a-c)}{(md+mn+2m-m^2+nd+d+d^2)(n+d+1)} > 0. \tag{3.20}$$

(ii) The market output change is given by

$$\sum_{k=1}^{n-m+1} q_k^* - \sum_{k=1}^{n} q_k^o = -\frac{m(m-1)(d+1)(a-c)}{(md+mn+2m-m^2+nd+d+d^2)(n+d+1)} < 0. \tag{3.21}$$

Mergers with diseconomies of scale always raise market price and reduce market output.

[2] $q_S^* - \sum_{i \in S} q_i^o = -\frac{m(n+d+1-m)(m-1)(a-c)}{(md+mn+2m-m^2+nd+d+d^2)(n+d+1)} < 0$

3.2.2 Profitability Conditions

The insiders' profit change is defined the same as in Section 3.1.2. Thus

$$\pi_S^* - \pi_S^o = -\frac{m(a-c)^2(m-1)(m(2+d)(-d^2-2md+m^2-3m+1-2mn+n^2+2n)+d(n+d+1)^2)}{2(md+mn+2m-m^2+nd+d+d^2)^2(n+d+1)^2}. \tag{3.22}$$

Proposition 6. *The following four claims are equivalent:*

(i) $\pi_S^* > \pi_S^o$

(ii) $m > m_1^*$

(iii) $d > Max\{d_1^*, 0\}$

(iv) $\theta > \theta_1^*$,

where m_1^*, d_1^* *and* θ_1^* *are given by*

$m_1^* = -\frac{1}{6(d+2)}t + \frac{3(d+2)v}{2t} + \frac{2}{3}d + \frac{2}{3}n + 1 - \frac{1}{2}i\sqrt{3}(\frac{1}{3(d+2)}t + \frac{3(d+2)v}{t})$

$d_1^* = \frac{1}{3(m-1)}\eta + \frac{z}{3(m-1)\eta} - \frac{2(m+m^2-1-n)}{3(m-1)}$

$\theta_1^* = \frac{m^*}{n}$,

which are the critical merger size, critical value of scale economy factor and critical combined pre-merger market share necessary for profitable mergers with diseconomies of scale.

In equation m_1^*, t and v are given by

$t = \sqrt[3]{(\alpha + 3\sqrt{\beta})(d+2)^2}$ and

$v = -\frac{7}{9}d^2 - \frac{2}{3} - \frac{1}{9}n^2 - \frac{2}{3}n - \frac{8}{9}nd - \frac{4}{3}d.$

In function t, variables α and β are given by

$\alpha = 17d^4 + (70+33)d^3 + (15n^2 + 117 + 93n)d^2 + (99n + 21n^2 + 90 - n^3)d - (2n+3)(n^2 - 6n - 9)$

$\beta = -3(d+1)^2(1+n+d)^2\sigma,$

where

$\sigma = -2d^2(nd - d^2 - 10d + n^2 - 12n - 18) + (16n^2 + 24 + 2n^3 + 36n)d + (4n+5)(1+n)^2.$

In equation d_1^*, η and z are given by

$\eta = \sqrt[3]{r + 3m^2\sqrt{u} - 3m\sqrt{u}}$

$z = (-16m^3 + 20m^2 - 6m^3n + 4m^2n + 3m^2n^2 + n^2 + 2n + 7m^4 + 1 - 8m - 8mn),$

where variables r and u are given by

$$r = m^5(18n - 17m + 66) + m^2(9n^3 - 60n - 54 - 24n^2) - (1+n)^2(n - 12m + 1)$$
$$- m^3(39mn + 126m + 9n^2m - 112 - 84n)$$

$$u = (m-1)(2m^6 - 8m^5n + 2m^5 - 12m^4 + 6m^4n + 24m^3 - 6m^3n - 9m^2 - 30m^2n + 11mn + m - n) + 3(n-m)(5m^3 + 9m - 2)n^4 - (m+1)^2n^5 + (14m - 27m^2 + 12m^3 - 8 - 11m^4)n^3 + (45m^3 - 8m - 24m^2 - 24m^4 + 2 + 13m^5)n^2.$$

It is worth noting that mergers formed by small subset of firms are profitable, even though they are in diseconomies of scale. The smaller profitable market share could be attributed to the quadratic cost in our model, which brings cost-savings to the insider firms following their merger. Example 5 explains a profitable merger with less than 80% pre-merger market share.

Example 5: Suppose $n = 10$, $m = 6$, and $d = 10$. Substituting them into $(\pi_S^* - \pi_S^o)$, we yield $\pi_S^* - \pi_S^o = \frac{2795}{764694}(a-c)^2$, which means the merging firms gain profits through the merger. Hence, in our example 60% pre-merger market share is sufficient for profit gains.

Regarding the likelihood to merge, we find that the greater the value of d, the more likely the insiders are going to merge. Put differently, as d goes up, the critical merger size necessary for profitable mergers goes down. Example 6 and Figure 3.1 explain this clearly.

Example 6: Consider a ten-firm market. Let d goes from $d = 1$ to $d = 10$ and to $d = 20$. Then their corresponding minimum profitable merger sizes are $7.072 + 1.0 * 10^{-9}i$, $3.3194 + 1.0 * 10^{-10}i$, and 2.136. It is obvious that the merger size becomes smaller as d becomes larger.

The right part of Figure 3.1 includes mergers that are in diseconomies of scale when $n = 10$.[3] The scale economy factor is assumed to change from 0 to 30. The downward sloping curve shows the lower boundary of the insiders' pre-merger market share necessary for mergers to be profitable at different levels of d. Mergers lying above this curve are profitable. It is obvious that many mergers with small sizes are profitable. The minimum market share for profitable mergers becomes smaller as the value of d becomes larger. It is surprising that the insiders' profitable market share could be as low as 20% or less. Since there are ten firms in the pre-merger market in Figure 3.1, 20% market share implies that there exist possibilities for two-firm mergers to be profitable.

As we will see, there exists a critical value of scale economy factor such that the minimum profitable merger size could be as small as two firms for any size of market. Let d_2^* define the critical value of d necessary for a two-firm merger to be profitable, then we yield

$$d > d_2^* = \frac{(50 - 46n + 13n^2)y^{\frac{1}{3}} - 10 + 2n}{3},$$

where

$$y = -289 + 429n - 219n^2 + 35n^3 + 6(-948 + 2316n - 2613n^2 + 1806n^3 - 816n^4 + 222n^5 - 27n^6)^{\frac{1}{2}}.$$

A merger comprised of two firms in a market can always be profitable as long as d is greater than d_2^*. Example 7 confirms this result.

[3] The smaller the number n of firms in the market, the flatter the profit curve would be. In general, however, the results are not substantially different for other relevant values of n.

Example 7: Consider a ten-firm market. Substituting $n = 10$ into d_2^*, we have $d_2^* = 22.382$. If a two-firm merger is profitable, then d must be greater than 22.382 based on the above condition. Let $d = 25 > 22.382$, then $\pi_S^* - \pi_S^o = \frac{23}{11290800}(a-c)^2 > 0$, which confirms our result. Let $d = 15 < 22.382$, then $\pi_S^* - \pi_S^o = -\frac{49}{2044900}(a-c)^2 < 0$, which implies that a two-firm merger is not desirable when d is smaller than its critical value.

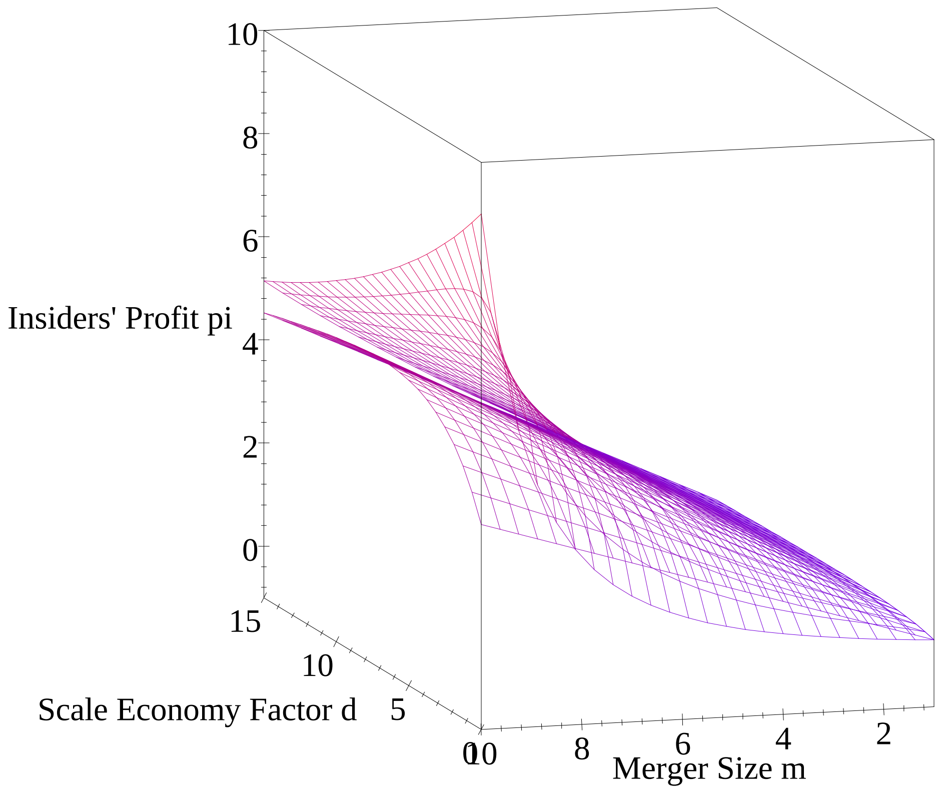

Figure 3.3: Profitability of mergers with diseconomies of scale when $n = 10$ in a three-dimensional graph.

For mergers with diseconomies of scale, we can also draw a three-dimensional graph showing the relationship between the insiders' profits and m and d. Such a graph is exemplified in Figure 3.3 which has the same axes as Figure 3.2, except that d runs from 0 to 15. In this graph, the top surface represents the post-merger profits, the bottom one represents the pre-merger profits and their differences represent the insiders' profit change. It is clear that only a small part of the post-merger profit surface (top one) falls below the pre-merger profit surface (bottom one) as d gets closer to zero. Consequently, in the market where firms are in diseconomies of scale, the set of profitable mergers is much larger than the one defined by SSR.

3.3 Mergers with Economies/Diseconomies of Scale

We have fully characterized the profitability conditions for mergers with economies of scale and mergers with diseconomies of scale. The effects of scale economy factor on mergers' profitability are diagrammatically shown in Figure 3.1.

Looking at the graph in Figure 3.1 as a whole, we obtain all profitable mergers that may arise in our Cournot model when there are ten firms in the market. The upward sloping line and the downward sloping curve are connected at the point where d is equal to 0. It is clear that when d is set to zero, our model is reduced to a symmetric Cournot market with identical and constant marginal costs. Put differently, at this point, merging does not generate any cost savings to the insiders. Consequently, the critical profitable market share for these mergers is higher than that for mergers with either economies or diseconomies of scale. It follows that the highest point on the inverse V shaped curve represents the minimum profitable market share for mergers with linear symmetric cost. The profit curve falls down from this point towards the left and right sides of the graph asymmetrically. The reason that the profit curve is not symmetric is because the market structures are different when the scale economy factor takes different signs. And this gives us the whole inverse V shaped curve in Figure 3.1.

Chapter 4

Welfare Effects

Chapter 4 focuses on the welfare effects the merging firms incur following the merger. We will examine the conditions that must be satisfied for a merger to be welfare-enhancing. We refer a merger to be welfare-enhancing when the post-merger social welfare is greater than the pre-merger social welfare. Thus a welfare-enhancing merger is beneficial to society. Due to the difference in the post-merger market structures, we will analyze mergers with economies of scale and mergers with diseconomies of scale separately. In Section 4.3, we analyze mergers' profitability and efficiency jointly.

4.1 Mergers with Economies of Scale

The welfare change as a consequence of merger is given by the difference of post-merger and pre-merger social welfare:

$$W^e - W^o = -\frac{(a-c)^2(m-1)((d^2+1)(d-m+2n+5)+d(-nm+n^2+5n-2m+6)-2)}{2(2+d+n-m)^2(n+d+1)^2}. \tag{4.1}$$

Proposition 7. *The following three claims are equivalent:*

(i) $W^e > W^o$

(ii) $d \in (-2, d_2^e)$ *and* $m < m_2^e$

(iii) $d \in (d_2^e, 0]$ *and* $m > m_2^e$,

where d_2^e *and* m_2^e *are given by*

$d_2^e = -1 - \frac{1}{2}n + \frac{1}{2}\sqrt{4n+n^2}$

$m_2^e = \frac{n^2d+5nd+d^3+5d^2+3+2nd^2+2n+7d}{d^2+1+2d+nd}$,

which are the critical value of the scale economy factor and critical merger size necessary for welfare-enhancing mergers with economies of scale.

Example 8 is an application of Proposition 7.

Example 8: Consider a ten-firm industry. Substituting $n = 10$ into equation d_2^e, we yield $d_2^e = -.08392$. Thus, range $(-2, d_2^e)$ becomes $(-2, -.08392)$. Suppose $d = -.3$, which is within range

$(-2, -.08392)$. Replacing n with 10 and d_2^e with $-.08392$ in equation m_2^e, we have $m_2^e = 8.7159$. According to part (ii) of Proposition 7, a welfare-enhancing merger needs a merger size smaller than 8.7159. Therefore, any merger with a size between 2 and 8 firms inclusive will be beneficial to society. Conversely, either monopoly or duopoly in this market will be harmful to society.

We can check this result by applying the social welfare change expression directly. Suppose a merger is formed by three firms in this industry. Substituting $m = 3$, $n = 10$, and $d = -.3$ into equation $(W^e - W^o)$, we yield $W^e - W^o = 1.6556 * 10^{-3}(a-c)^2$, which is positive. This proves that a merger with a size between $[2, 8]$ increases social welfare. On the other hand, a monopoly reduces social welfare and this is shown as follows: substituting $m = 10$, $n = 10$, and $d = -.3$ into $(W^e - W^o)$, we yield $W^e - W^o = -4.3834 * 10^{-2}(a-c)^2$, which is negative as expected.

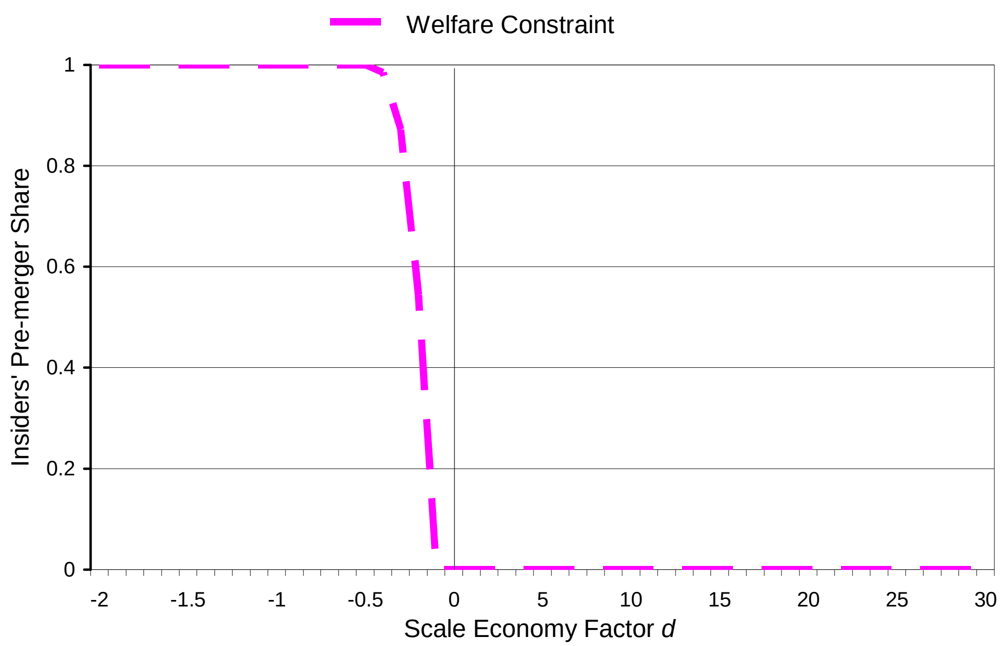

Figure 4.1: Welfare effects of mergers with economies/diseconomies of scale when $n = 10$. Notes: The set of welfare-enhancing mergers is included in the area bounded from the above by the welfare curve.

Figure 4.1 is composed of two parts: the left (right) part illustrates the welfare effects for mergers with economies (diseconomies) of scale when $n = 10$. [1] The insiders locating on the vertical middle line have constant average and marginal costs and thus do not enjoy cost savings after the merger. The dotted curve shows the upper boundary of the market share necessary for mergers to be welfare-enhancing. All mergers that lie below the dotted line are beneficial to public interest.

[1] The smaller the total number n of firms, the greater the absolute value of d required for the dotted welfare line to reach 100% market share. However, the results are not substantially different for other relevant values of n.

It is worth noting that the welfare curve reaches 100% market share at a relatively small absolute value of d. This implies that many mergers including monopolies with sufficient economies of scale are desirable to society. In addition, the welfare curve moves down to 0% market share at $d = -.15$ when $n = 10$. We obtain similar results for markets with different sizes. This means mergers with very small economies of scale can not improve social efficiency.

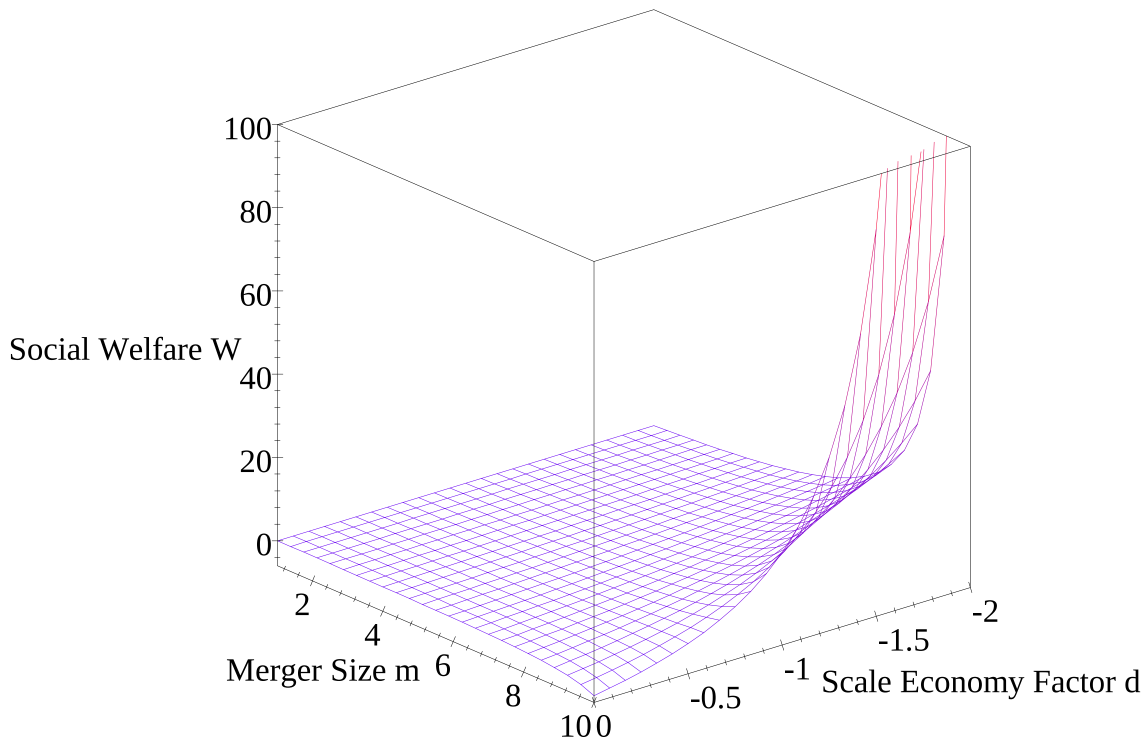

Figure 4.2: Welfare effects of mergers with economies of scale when $n = 10$ in a three-dimensional graph.

The welfare effects of mergers with economies of scale can also be illustrated by a three-dimensional graph, which shows the relationship between social welfare and m and d. In Figure 4.2, the vertical axis defines the insiders' welfare change ($W^e - W^o$) and the horizontal axes define merger size m and the scale economy factor d respectively. It is obvious that most combinations of m and d are located on the positive side of the vertical axis. This indicates that most mergers in this market are welfare-enhancing. This result is consistent with the one obtained in Figure 4.1. It is also obvious that as the merger size increases and d approaches -2, social welfare improves extremely fast. As a result, in the market where firms are in economies of scale, mergers with large size and greater economies of scale contribute substantially to social welfare.

4.2 Mergers with Diseconomies of Scale

The welfare change as a consequence of merger is defined the same way as in Section 4.1:

$$W^* - W^o = -\frac{m(a-c)^2(m-1)((m-1)n^2d + (2+2d^2+5d-md)mn + (d+1)^2(d+md-m^2+3m))}{2(md+mn+2m-m^2+nd+d+d^2)^2(n+d+1)^2} \tag{4.2}$$

Proposition 8. *Mergers with diseconomies of scale (i.e., $d > 0$) always reduce social welfare.*

Proposition 8 implies that in the market where firms are in diseconomies of scale, mergers are publicly harmful. These mergers will most likely be discouraged by the antitrust authorities due to their negative effects on social welfare, although they are generally privately profitable. Example 9 shows a merger which increases its profits, but reduces social welfare.

Example 9: Consider a market with ten firms and all firms are merging into a monopoly (i.e., $m = n = 10$). Suppose $d = 1$, we yield $W^* - W^o = -\frac{235}{2352}(a-c)^2 < 0$, while $\pi_S^* - \pi_S^o = \frac{15}{112}(a-c)^2 > 0$. This example confirms our result in Proposition 8.

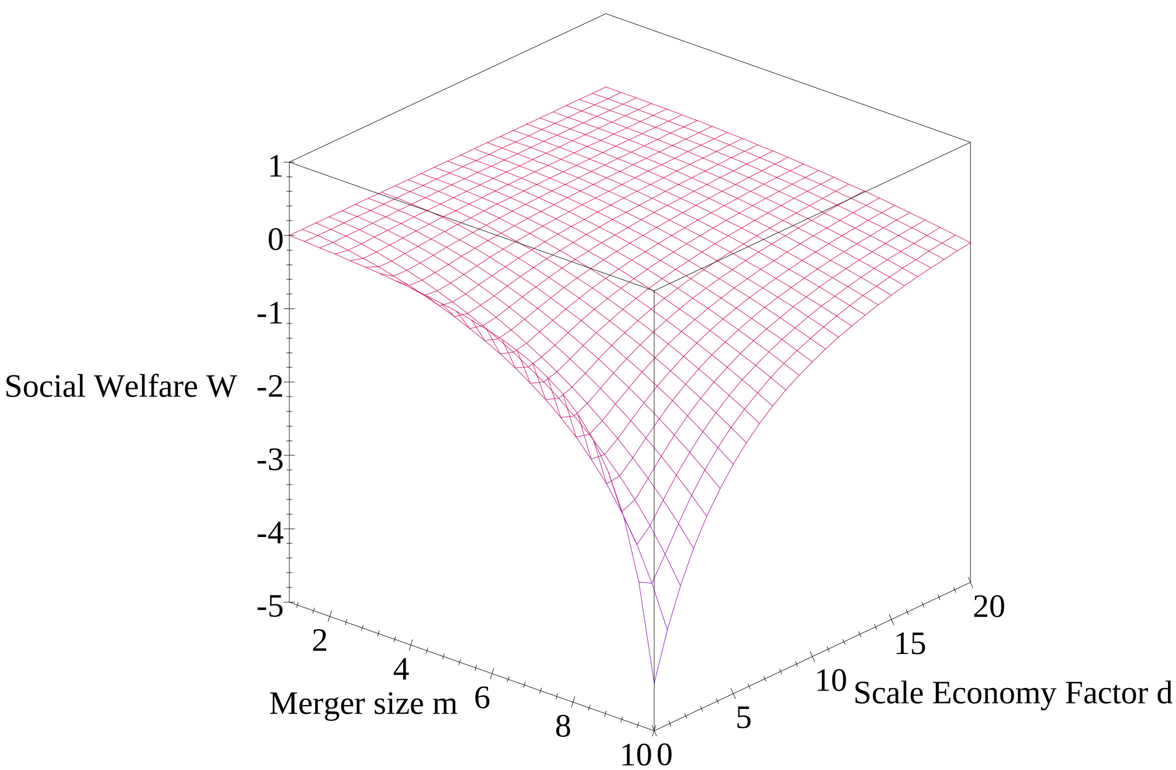

Figure 4.3: Welfare effects of mergers with diseconomies of scale when $n = 10$ in a three-dimensional graph.

The reason that welfare loss arises in this market can be explained as follows. As we have shown in Section 3.2.1 that consumer surplus will definitely go down after the merger. Thus, for social welfare to increase, the post-merger total profits must increase by more than the decrease in consumer surplus. Unfortunately, in the presence of diseconomies of scale, the profit increase in the market is always dominated by the decrease in consumer surplus, which leads to losses in social welfare.

As mentioned before, the right part of Figure 4.1 illustrates the welfare effects of mergers with diseconomies of scale (i.e., $d > 0$) when $n = 10$. The dotted welfare line defines the upper boundary for welfare-enhancing mergers. It locates exactly on the horizontal axis, which shows that all mergers with diseconomies of scale are harmful to social welfare.

Similar to mergers with economies of scale, we can also show the relationship between the social welfare and m and d for mergers with diseconomies of scale in a three-dimensional graph. In Figure 4.3, the three axes are defined the same way as in Figure 4.2, although d now is changing from 0 to 20. Figure 4.3 shows that change in social welfare is negative for all combinations of m and d. Moreover, as merger size increases and d approaches zero, social welfare deteriorates extremely fast. Figure 4.3 confirms the result we obtained mathematically.

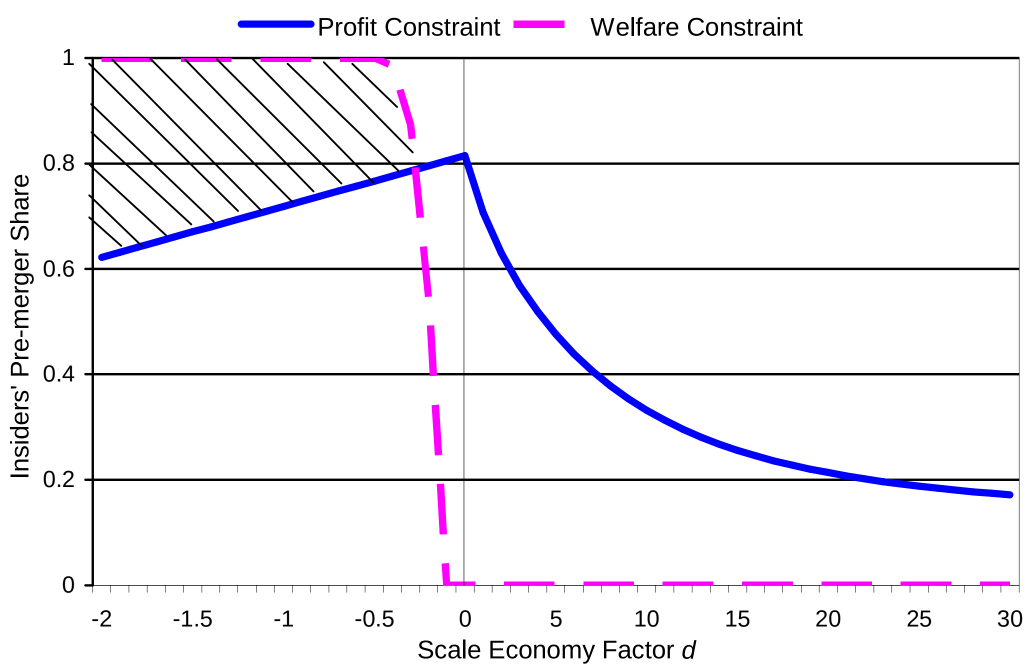

Figure 4.4: Profitability and efficiency of mergers with economies/diseconomies of scale when $n = 10$. Notes: The set of profitable and welfare-enhancing mergers is included in the shaded area.

4.3 Mergers with Economies/Diseconomies of Scale

We have precisely characterized how a merger's profitability and efficiency are affected by its size m and by its scale economy factor d separately. We are now in a position to examine the merger's effects on its profitability and social welfare.

Figure 4.4 is a combination of Figure 3.1 and Figure 4.1, which illustrates mergers' profitability and efficiency in the presence of economies/diseconomies of scale when the number of firms in the market is ten. The set of profitable and welfare-enhancing mergers is included in the shaded area, which is bounded from above by the dotted welfare line and from below by the profit line.

In Figure 4.4, the set of profitable and welfare-enhancing mergers has more than 50% combined pre-merger market share and are all in economies of scale. However, as number n of firms reduces to a certain value, mergers with less than half of the market share could also be profitable and welfare-enhancing. In particular, the smaller the industry size, the lower the minimum level of market share that a set of profitable and welfare-enhancing mergers could reach. It is clear that mergers with substantial economies of scale have greater probabilities of falling in the shaded area, and are therefore more likely to benefit the insiders and public interest. On the other hand, mergers with diseconomies of scale or mergers with small economies of scale hurt social welfare. The welfare curve of these mergers matches exactly with the horizontal axis in Figure 4.4. It is obvious that for these mergers, no common area is bounded by both profit and welfare curves.

Chapter 5

Conclusions and Future Work

This thesis studies the profitability and welfare effects of mergers in a Cournot Oligopoly model with linear demand and quadratic costs. The scale economy factor d, which has not been studied in previous work, is a key factor in determining the necessary and sufficient conditions to be profitable and welfare-enhancing. This parameter is also the factor that makes our results significantly different from those obtained in previous literature.

We have shown that mergers with diseconomies of scale always raise prices and reduce output, which leads to deterioration of consumer surplus and contributes negatively to social welfare. Large economies of scale are required for a merger to lower prices and increase output. In other words, this can happen only when d is taking values between -2 and -1. It has been noticed that at $d = -1$, the post-merger equilibrium price and output remain unchanged. Furthermore we have shown that, although counterintuitive, monopolies could increase consumer surplus and social welfare by reducing market price and increasing output.

In our analysis on profitability, we have examined the conditions that must be satisfied for a merger to be profitable. We found that the greater the (absolute) value of the scale economy factor, the more likely the insiders are going to merge. In contrast to the 80% critical market share in the linear symmetric model, the scale economy factor in our model makes many smaller mergers profitable. It is worth noting that in the market with diseconomies of scale, a merger formed by two firms is always profitable as long as the scale economy factor is greater than d_2^* the critical value required for a two-firm merger to be profitable. Moreover when all firms in the market merge into a monopoly, total profits always increase. [1]

In our analysis on efficiency, we have characterized the critical merger size and the critical scale economy factor necessary for mergers with economies of scale to be welfare-enhancing. In the presence of negative d, most mergers that are profitable are efficient as well. The joint pre-merger

[1] For mergers with economies of scale, let $f(m,n,d) = -(m(m-2d-3-2n)+d(2n+d+2)+(n+1)^2)$. A merger is profitable when $f(m,n,d) > 0$. When $m = n$, $f(m,n,d)$ reduces to $f(n,n,d) = n-(d+1)^2 > 0$.
For mergers with diseconomies of scale, let $g(m,n,d) = -(m(2+d)(-d^2-2md+m^2-3m+1-2mn+n^2+2n)+d(n+d+1)^2$. A merger is profitable when $g(m,n,d) > 0$. When $m = n$, $g(m,n,d)$ reduces to $g(n,n,d) = (d+1)^2(n-1)(2n+d) > 0$.
This proves that merging into monopolies always increases the insiders' profits.

market share of the profitable and efficient mergers with economies of scale is typically greater than 50%, but it could fall below 50% in the industry with a relatively small n. In general, the lowest level of share that a profitable and efficient merger could reach is positively related with the industry size. On the other hand, at a given industry size, mergers with greater economies of scale are more likely to be beneficial to society. However, mergers with diseconomies of scale would bring no benefits to the public interest. As a consequence, mergers that arise in this market would most probably be discouraged by the antitrust authorities.

It should be fairly obvious that our thesis provides useful implications for horizontal merger policy. We list some implications as follows:

- In the presence of economies of scale, mergers, even if monopolies, could improve consumer surplus following the merger. Furthermore, there is a large set of welfare-enhancing mergers including monopolies in this market, which are supposed to be approved by the antitrust agencies based on the efficiency standard. Therefore, although mergers reduce market competition and are traditionally thought of as not beneficial to society, our result shows that they do in fact improve social welfare. As a result of this observation, an adjustment on policies toward competition may arise.
- We have shown that mergers with diseconomies of scale are detrimental to public interest. According to this result, the antitrust agencies may need to prohibit those proposed mergers with diseconomies of scale.

There are some research topics which can be explored by extending our model. We list four future topics as below:

- We analyze a homogeneous-goods market and thus our results may not apply well to the markets with differentiated products. Yet, analysis on differentiated-product markets is an important topic for future research.
- Our pre-merger market is symmetric due to the constant c in the cost function. Our model can be made more challenging by replacing c with c_j where $j = 1, ..., n$ and $c_j \neq c_k$ for $j \neq k$. We believe that an examination of the Cournot model with asymmetric quadratic costs would provide valuable implications on antitrust policies. This is an issue that needs to be addressed in future research.
- It is useful to add transaction cost to our model, which is an important factor in affecting a merger's profitability and efficiency.
- It is also useful to add fixed cost in merger analysis. With fixed costs, firms need higher price or greater demand to maintain their original profit level when no fixed cost is present. In

contrast to the equilibrium market size when fixed costs are not taken into consideration, the equilibrium market size must be smaller when fixed costs are present in firms' cost functions. Therefore, in the pre-merger market, the aggregate profits of the m merging firms would be reduced. This will clearly change the conditions necessary for profitable and efficient mergers. Full analysis will be a challenging independent study.

Appendix

Proof of Proposition 1

We would like to derive the post-merger cost function for mergers with diseconomies of scale first. The merging firms want to minimize their combined costs subject to the supply constraint. Their cost function with constraint following the merger is presented as

$C_S(q_S) = Min\{\sum_{i\in S} C_i(q_i)\}$ s.t. $\sum_{i\in S} q_i = q_S$.

Setting up Lagrangian to get the first-order conditions for cost minimization, we have

$L = \sum_{i\in S} c_i(q_i) - \lambda(\sum_{i\in S} q_i - q_S)$ and

$\frac{\partial L}{\partial q_i} = 0 \Leftrightarrow c + dq_i - \lambda = 0$,for $i = 1, ..., m$

From above equations, we yield $q_1 = q_2 = ... = q_m$. Let $q_i = q$, then the insiders' post-merger output would be $q_S = mq$. The post-merger equilibrium output for each merging firm would be $q^* = \frac{q_S}{m}$. Thus, the insiders' post-merger cost function for mergers with diseconomies of scale would be $C_S(q_S) = cq_S + \frac{d}{2m}q_S^2$.

Q.E.D.

The post-merger cost function for mergers with economies of scale is derived in the same process, which is given by $C_S(q_S) = cq_S + \frac{d}{2}q_S^2$. The reason that m is missing in this function is that in the presence of negative d, the greatest cost saving can be obtained if and only if the insider group operate as a single firm following the merger. This requires all but one firm in the insiders move out of the post-merger market. The merger achieves its minimum cost when operating in 1 unit rather than m units, which results in a replacement of 1 for m in the denominator of the cost function. The rest part remains the same and this gives us the above function.

Q.E.D.

Proof of Proposition 2

For each individual firm j, its profit is defined as

$\pi_j = (a - \sum q_k)q_k - (cq_j + \frac{d}{2}q_j^2)$,

so its first-order condition is

$\frac{\partial \pi_j}{\partial q_j} = (a - \sum_k q_k) - q_j - (c + dq_j) = 0.$ (1)

By symmetry among all firms, equation (1) becomes

$(a - nq_j) - q_j - (c + dq_j) = 0,$

where q_j is an individual firm's supply. Solving for q_j leads to Proposition 2.

Q.E.D.

Proof of Proposition 3

For each outsider firm j, its profit is defined as

$\pi_j = (a - \sum q_k)q_k - (cq_j + \frac{d}{2}q_j^2),$

so its first-order condition is

$\frac{\partial \pi_j}{\partial q_j} = (a - \sum_k q_k) - q_j - (c + dq_j) = 0.$ (2)

For the merged firm S, its profit is defined as

$\pi_S = (a - \sum q_k)q_S - (cq_S + \frac{d}{2}q_S^2),$

so its first-order condition is

$\frac{\partial \pi_S}{\partial q_S} = (a - \sum_k q_k) - q_S - (c + dq_S) = 0.$ (3)

Because the post-merger market is symmetric, equations (2) and (3) become

$(a - (n - m + 1)q_j) - q_j - (c + dq_j) = 0,$

where q_j is both the merger's output and each outsider firm's output. Solving for q_j leads to Proposition 3.

Q.E.D.

Proof of Corollary 1

The market price change is

$$\begin{aligned}(P^e - P^o) &= \frac{a(1+d) + (n-m+1)c}{2+d+n-m} - \frac{a + ad + cn}{n+d+1} \\ &= \frac{(a-c)(m-1)(1+d)}{(2+d+n-m)(n+d+1)}.\end{aligned}$$

The denominator is positive, while the sign of $(1+d)$ could be positive and negative. Therefore, the post-merger market price could either rise or fall. When $-1 < d \leq 0$ $(-2 < d < -1)$, the merger would raise (decrease) price; while when $d = -1$, the market price remains unchanged.

The insiders' output change is

$$\begin{aligned}(q_S^e - \sum_{i \in S} q_i^o) &= \frac{a-c}{2+d+n-m} - \frac{m(a-c)}{n+d+1} \\ &= \frac{(a-c)(m-1)(-m+n+d+1)}{(2+d+n-m)(n+d+1)}.\end{aligned}$$

The sign of $(-m+n+d+1)$ is undetermined. At $m=n$, $q_S^e > \sum_{i\in S} q_i^o$ ($q_S^e < \sum_{i\in S} q_i^o$) for $-1 < d \leq 0$ ($-2 < d < -1$). Other than monopoly, any other size of merger would result in lower output for the merging party.

Q.E.D.

Proof of Proposition 4

Consider each part in turn:

$(i) \Leftrightarrow (ii)$: The insiders' profit change is given by

$(\pi_S^e - \pi_S^o) = -\frac{(a-c)^2(d+2)(m-1)(m(m-2d-3-2n)+d(2n+d+2)+(n+1)^2)}{2(2+d+n-m)^2(n+d+1)^2}$.

Let

$g(m,n,d) = -(m(m-2d-3-2n)+d(2n+d+2)+(n+1)^2)$.

Solving $g(m,n,d) > 0$ for m, we have the following solution:

$m > m_1^e$ or $m < m_3^e$,

where

$m_1^e(n,d) = \frac{3}{2} + n + d - \frac{1}{2}\sqrt{5+4n+4d}$ and

$m_3^e(n,d) = \frac{3}{2} + n + d + \frac{1}{2}\sqrt{5+4n+4d}$.

The second root is inadmissible since it obviously exceeds n. The first root is the one of interest and the only one in $[1,n]$.

The slope of $g(m,n,d)$ with respect to m is $(-2m+3+2n+2d)$. Evaluating the slope at $m=m_1^e$, we have $\sqrt{5+4n+4d}$, which is greater than zero. That is to say $g(m,n,d)$ is upward sloping at $m=m_1^e$. We need $g(m,n,d)>0$ to make the merger profitable. Therefore, $m>m_1^e$ is acceptable. In other words, any m in the interval $(m_1^e, n]$ satisfies $g(m,n,d)>0$. This proves the equivalence between (i) and (ii).

$(ii) \Leftrightarrow (iii)$: Solving $g(m,n,d)>0$ for d, we have the following solution:

$d_3^e < d < d_1^e$,

where

$d_1^e = m-1-n+\sqrt{m}$ and

$d_3^e = m-1-n-\sqrt{m}$.

The second root d_3^e is always less than -2 and is therefore inadmissible. The root that is of interest is d_1^e. If the merger size is close to the market size, a merger will always be profitable for any value of d within $(-2,0]$. When it comes to this situation, d_1^e could be positive. The condition of $d<d_1^e$ is not satisfactory. We therefore set a higher boundary of zero for d to ensure that d can always fall in a feasible range of values. For example, if all firms merge into a monopoly, $g(m,n,d)$ reduces to $g(n,n,d) = n-d^2-2d-1$. Let $g(n,n,d)>0$. The solution to it would be: $d_3^e < d < d_1^e$, where $d_3^e = -1-\sqrt{n}$, which is invalid, and $d_1^e = -1+\sqrt{n}$, which is positive. $d < d_1^e = -1+\sqrt{n}$ implies that the monopoly is profitable as long as d takes values between $(-2, 0]$. Since $(-2, 0]$ is part of (d_3^e, d_1^e), the former range is accepted.

However, if the merger size, compared to the market size, is at a relatively small level, a merger can never be profitable for $d \in (-2, 0]$. This is because both d_3^e and d_1^e are smaller than -2, which contradicts the constraint on d. For instance, there are fifteen firms in the industry and ten of them are proposed to merge, then $g(m, n, d)$ will be translated into $g(10, 15, d) = 26 + 12d + d^2$. Solving this equation for d, we have $d_3^e = -9.1623$ and $d_1^e = -2.8377$. Thus, $d < d_1^e$ is not feasible and a merger of this size is unprofitable in this case.

$(iii) \Leftrightarrow (iv)$: Since all firms are the same prior to the merger, each has the same market share $\frac{1}{n}$. The critical market share is equal to the critical number of firms multiplied by an individual firm's market share, or $\theta_1^e = (\frac{m_1^e}{n})$.

Q.E.D.

Proof of Corollary 2

The change in m_1^e as change in d is obtained as

$\frac{\partial m_1^e}{\partial d} = \{1 - (5 + 4n + 4d)^{-\frac{1}{2}}\} > 0.$

Since $(5 + 4n + 4d)^{-\frac{1}{2}} \in (0, 1)$, the whole expression would be greater than zero. Therefore, small values of economies of scale reduce the minimal joint market share required for profitable mergers.

Q.E.D.

Proof of Proposition 5

For each outsider j, its profit is defined as

$\pi_j = (a - \sum q_k)q_j - (cq_j + \frac{d}{2}q_j^2),$

so its first-order condition is

$\frac{\partial \pi_j}{\partial q_j} = (a - \sum_k q_k) - q_j - (c + dq_j) = 0.$ (4)

For the merged firm S, its profit is defined as

$\pi_S = (a - \sum q_k)q_S - (cq_S + \frac{d}{2m}q_S^2),$

so its first-order condition is

$\frac{\partial \pi_S}{\partial q_S} = (a - \sum_k q_k) - q_S - (c + \frac{d}{m}q_S) = 0.$ (5)

By symmetry among outsiders, equations (4) and (5) become

$(a - q_S - (n - m)q_j) - q_j - (c + dq_j) = 0$ and

$(a - q_S - (n - m)q_j) - q_S - (c + \frac{d}{m}q_S) = 0,$

where q_S is the merger's supply and q_j is an outsider's supply. Solving for q_S and q_j leads to Proposition 5.

Q.E.D.

Proof of Corollary 3

The market price and output change are respectively given by

$$
\begin{aligned}
(P^* - P^o) &= \frac{a(md + m + d + d^2) + c(m + mn - m^2 + nd)}{md + mn + 2m - m^2 + nd + d + d^2} - \frac{a + ad + cn}{n + d + 1} \\
&= \frac{m(m-1)(d+1)(a-c)}{(md + mn + 2m - m^2 + nd + d + d^2)(n + d + 1)} > 0 \text{ and}
\end{aligned}
$$

$(\sum_{k=1}^{n-m+1} q_k^* - \sum_{k=1}^{n} q_k^o) = -\frac{m(m-1)(d+1)(a-c)}{(md+mn+2m-m^2+nd+d+d^2)(n+d+1)} < 0$

Therefore, in the market with diseconomies of scale the market price will always rise and market output will always decrease following the merger.

Q.E.D.

Proof of Proposition 6

Consider each part in turn

$(i) \Leftrightarrow (ii)$: The insiders' profit change is given by

$(\pi_S^* - \pi_S^o) = -\frac{m(a-c)^2(m-1)[m(2+d)(-d^2-2md+m^2-3m+1-2mn+n^2+2n)+d(n+d+1)^2]}{2(md+mn+2m-m^2+nd+d+d^2)^2(n+d+1)^2}$.

Let

$f(m,n,d) = -[m(2+d)(-d^2 - 2md + m^2 - 3m + 1 - 2mn + n^2 + 2n) + d(n+d+1)^2]$

Solving $f(m,n,d) = 0$ for m, we have three roots:

$m_1^* = -\frac{1}{6(d+2)}t + \frac{3(d+2)v}{2t} + \frac{2}{3}d + \frac{2}{3}n + 1 - \frac{1}{2}i\sqrt{3}(\frac{1}{3(d+2)}t + \frac{3(d+2)v}{t})$,

$m_3^* = -\frac{1}{6(d+2)}t + \frac{3(d+2)v}{2t} + \frac{2}{3}d + \frac{2}{3}n + 1 + \frac{1}{2}i\sqrt{3}(\frac{1}{3(d+2)}t + \frac{3(d+2)v}{t})$, and

$m_4^* = \frac{1}{3(d+2)}t - \frac{3(d+2)v}{t} + \frac{2}{3}d + \frac{2}{3}n + 1$,

where t and v are given by

$t = \sqrt[3]{(\alpha + 3\sqrt{\beta})(d+2)^2}$ and

$v = -\frac{7}{9}d^2 - \frac{2}{3} - \frac{1}{9}n^2 - \frac{2}{3}n - \frac{8}{9}nd - \frac{4}{3}d$.

In function t, variables α and β are given by

$\alpha = 17d^4 + (70 + 33)d^3 + (15n^2 + 117 + 93n)d^2 + (99n + 21n^2 + 90 - n^3)d - (2n+3)(n^2 - 6n - 9)$

and

$\beta = -3(d+1)^2(1+n+d)^2\sigma$,

where

$\sigma = -2d^2(nd - d^2 - 10d + n^2 - 12n - 18) + (16n^2 + 24 + 2n^3 + 36n)d + (4n+5)(1+n)^2$

The first root m_1^* is the one of interest and the only one in $[1,n]$. By counterproof, we are able to eliminate roots m_3^* and m_4^*.

For instance, suppose $n = 10$ and $d = 1$, then $f(m,n,d)$ reduces to $f(m,15,1) = -3m^3 + 75m^2 - 360m - 144$. Let $f(m,10,1) > 0$, we have the following solution: $m < m_3^*$ and $m_1^* < m < m_4^*$, where $m_3^* = -.37091 - 3.0 * 10^{-9}i$, $m_1^* = 7.072 + 1.0 * 10^{-9}i$ and $m_4^* = 18.299$. It is evident that m_3^* and m_4^* should be eliminated because m_3^* is less than zero and m_4^* is larger than n, which make both of them invalid solutions for a merger. Then m_1^* is the only valid root for $f(m, n, d)$. We also noticed that the merger size should be greater than m_1^* to make a merger profitable.

We can also check the value of m_1^* at $d = 0$ to see if it is consistent with the critical merger size obtained in the linear symmetric Cournot Oligopoly model in SSR.

In our model, the critical merger size at $d = 0$ is

$$m_1^*(n, d = 0) = -\frac{1}{12}\sqrt[3]{4(27 + 36n + 9n^2 - 2n^3 + 3\sqrt{-15 - 72n - 63n^4 - 12n^5 - 138n^2 - 132n^3})}.$$

Suppose $n = 15$, then $m_1^*(15, 0) = 12.469$. Thus, the critical market share for a profitable merger would be $m_1^*(15, 0)/n = 12.469/15 = 0.8313$.

In SSR, varialbe α_2 is the break-even market share and is defined by the following expression:

$$\alpha_2 = \frac{(2n+3) - \sqrt{4n+5}}{2n}.$$

Thus, when the industry size is 15, α_2 is translated to $\alpha_2 = \frac{33-\sqrt{65}}{30} = 0.8313$, which is the same as in our model. This proves that m_1^* is an admissible root. (The critical market share is consistent at other market size as well.) Hence, this proves the equivalence between (i) and (ii).

$(ii) \Leftrightarrow (iii)$: Solving $f(m, n, d) = 0$ for d, we have three roots:

$$d_1^*(m, n) = \frac{1}{3(m-1)}\eta + \frac{z}{3(m-1)\eta} - \frac{2(m+m^2-1-n)}{3(m-1)},$$

$$d_3^*(m, n) = -\frac{\eta}{6(m-1)} - \frac{z}{6(m-1)\eta} - \frac{2(m+m^2-1-n)}{3(m-1)} + \frac{\sqrt{3}}{2}i\left(\frac{\eta}{3(m-1)} - \frac{z}{3(m-1)\eta}\right),$$

and

$$d_4^*(m, n) = -\frac{\eta}{6(m-1)} - \frac{z}{6(m-1)\eta} - \frac{2(m+m^2-1-n)}{3(m-1)} - \frac{\sqrt{3}}{2}i\left(\frac{\eta}{3(m-1)} - \frac{z}{3(m-1)\eta}\right),$$

where η and z are defined as

$$\eta = \sqrt[3]{r + 3m^2\sqrt{u} - 3m\sqrt{u}}, \text{ and}$$

$$z = (-16m^3 + 20m^2 - 6m^3n + 4m^2n + 3m^2n^2 + n^2 + 2n + 7m^4 + 1 - 8m - 8mn).$$

In equation η, variables r and u are given by

$$\begin{aligned} r = {} & m^5(18n - 17m + 66) + m^2(9n^3 - 60n - 54 - 24n^2) - (1+n)^2(n - 12m + 1) \\ & - m^3(39mn + 126m + 9n^2m - 112 - 84n) \end{aligned}$$

$$\begin{aligned} u = {} & (m-1)(2m^6 - 8m^5n + 2m^5 - 12m^4 + 6m^4n + 24m^3 - 6m^3n - 9m^2 - 30m^2n + 11mn + m - n) \\ & + 3(n-m)(5m^3 + 9m - 2)n^4 - (m+1)^2n^5 + (14m - 27m^2 + 12m^3 - 8 - 11m^4)n^3 \\ & + (45m^3 - 8m - 24m^2 - 24m^4 + 2 + 13m^5)n^2. \end{aligned}$$

d_3^* and d_4^* are always negative and are therefore inadmissible. The only root that is valid is d_1^*.

When the merger size is close to the market size, a merger will always be profitable irrelevant to the values of d. When it comes to this situation, d_1^*, the only valid root, could be negative, which makes no sense since d must be greater than zero. For example, when all firms merge into a monopoly, $g(m,n,d)$ reduces to

$g(n,n,d) = (4dn^2 + 2d^2n^2 + 2n^2 - 2n + d^3n - 3nd - 2d^2 - d^3 - d)$.

Let $g(n,n,d) > 0$. The solution to it would be:

$\{d_1^* = d_3^* > -1\}$ or $\{d_4^* < -2n\}$.

The latter inequality is obviously infeasible. The former one implies that a monopoly is profitable as long as d is greater than -1. Since d is positive, any merger into monopoly is profitable. To be consistent with the constraint on d, zero becomes the lower boundary for d in case d_1^* is negative. This proves the equivalence between (ii) and (iii).

$(iii) \Leftrightarrow (iv)$: Since all firms are the same prior to the merger, each has the same market share $\frac{1}{n}$. The critical market share is equal to the critical number of firms multiplied by an individual firm's market share, or $\theta_1^* = \frac{m_1^*}{n}$.

Q.E.D.

Proof of Proposition 7

Consider all three parts together.

The welfare change is given by

$(W^e - W^o) = -\frac{(a-c)^2(m-1)[(d^2+1)(d-m+2n+5)+d(-nm+n^2+5n-2m+6)-2]}{2(2+d+n-m)^2(n+d+1)^2}$.

Let

$l(m,n,d) = -[(d^2+1)(d-m+2n+5) + d(-nm+n^2+5n-2m+6) - 2]$.

Whether the social welfare increases or decreases depends on the sign of $l(m,n,d)$. If $l(m,n,d) > 0 (< 0)$, the society will be benefited (harmed). Solving $l(m,n,d) = 0$ for m, we yield

$m_2^e = \frac{n^2d+5nd+d^3+5d^2+3+2nd^2+2n+7d}{d^2+1+2d+nd}$.

If $l(m,n,d)$ is strictly increasing (decreasing), it will be positive (negative) for all $m > m_2^e$, which correspondingly results in rises (falls) in social welfare. Moreover, if $l(m,n,d)$ is strictly increasing (decreasing), it will be negative (positive) for all $m < m_2^e$ and this will result in losses (gains) in social welfare.

The slope of $l(m,n,d)$ can be obtained by taking the derivative of $l(m,n,d)$ with respect to m and the slope is given by $r(n,d) = d^2 + 1 + 2d + nd$, the sign of which is undetermined. As a consequence, $l(m,n,d)$ can be either upward sloping or downward sloping.

Let $r(n,d) = 0$ and solve it for d, we yield two roots:

$\{d_2^e = -1 - \frac{1}{2}n + \frac{1}{2}\sqrt{4n+n^2}\}$ and

$\{d_5^e = -1 - \frac{1}{2}n - \frac{1}{2}\sqrt{4n+n^2}\}$.

d_5^e is inadmissible since it is obviously out of $(-2,0]$. The root that is of interest is d_2^e. The second derivative of $r(n,d)$ with respcet to d is 2, which indicates that $r(n,d)$ is a convex function. It follows that $r(n,d) > 0 (< 0)$ for $d < d_5^e (d_5^e < d < d_2^e)$. The range of $d < d_5^e$ should be eliminated since d can not be less than -2. Therefore, when $r(n,d) > 0$, $l(m,n,d)$ is upward sloping and the feasible range for d is $d_2^e < d \leq 0$. When $r(n,d) < 0$, $l(m,n,d)$ is downward sloping and $2 < d < d_2^e$ is the feasible range. (Since d_5^e is less than -2 , we need to replace d_5^e with -2 in this range.) Q.E.D.

Proof of Proposition 8

The welfare change is given by

$$(W^* - W^o) = -\frac{m(a-c)^2(m-1)[(m-1)n^2d+(2+2d^2+5d-md)mn+(d+1)^2(d+md-m^+3m)]}{2(md+mn+2m-m^2+nd+d+d^2)^2(n+d+1)^2}.$$

The social welfare will be enhanced if $(W^* - W^o) > 0$ and the social welfare will be harmed if $(W^* - W^o) < 0$. Let

$$k(m,n,d) = (m-1)n^2d + (2+2d^2+5d-md)mn + (d+1)^2(d+md-m^2+3m).$$

Solving $k(m,n,d) = 0$ for m, we have two roots:

$$m_5^* = \frac{1}{2(1+2d+nd+d^2)}(d^3+5nd+n^2d+5d^2+2n+7d+3+2nd^2+\sqrt{\delta}),\text{ and}$$

$$m_6^* = \frac{1}{2(1+2d+nd+d^2)}(d^3+5nd+n^2d+5d^2+2n+7d+3+2nd^2-\sqrt{\delta}),$$

where δ is defined as

$$\delta = n^3d(4d^2+nd+6d+4)+n^2(6d^4+39d^2+22d+4+26d^3)+(d+9)(d+1)^5+2n(2d^2+11d+6)(d+1)^3$$

It is obvious that $m_5^* > m_6^*$.

The second derivative of $k(m,n,d)$ with respcet to m is $2(-d^2-1-2d-nd)$, which is negative in the presence of positive d. This implies that $k(m,n,d)$ is a concave function in m. It follows that $k(m,n,d)$ is above the horizontal axis (actually, the m axis) when $m \in (m_6^*, m_5^*)$ and below the m axis when $m < m_6^*$ or $m > m_5^*$. Because of the negative sign in front of the whole expression of $(W^* - W^o)$, the social welfare will reduce when $m \in (m_6^*, m_5^*)$ and increase when $m < m_6^*$ or $m > m_5^*$.

We need to compare m_6^* and m_5^* with 1 and n respectively to make sure that the above ranges are feasible for a merger of size m.

Since m_6^* is the smaller root, we only need to compare it with 1, the lower boundary for m. Subtracting 1 from m_6^*, we yield

$$(m_6^* - 1) = \frac{d^3+3nd+n^2d+3d^2+2n+3d+1+2nd^2-\sqrt{\delta}}{2(1+2d+nd+d^2)}.$$

Since $d^3+3nd+n^2d+3d^2+2n+3d+1+2nd^2 < \sqrt{\delta}$, then $m_6^* < 1$. This result would remove range $m < m_6^*$ out since m can not be less than 1. Therefore $m < m_6^*$ is an infeasible range.

Taking the difference of m_5^* and n, we have

$$(m_5^* - n) = \frac{d^3+nd-n^2d+5d^2+7d+3+\sqrt{\delta}}{2(1+2d+nd+d^2)}.$$

Since $d^3+nd+5d^2+7d+3+\sqrt{\delta} > n^2d$, then $m_5^* > n$. This result would remove range $m > m_5^*$ out since m can not be greater than n. Therefore $m > m_5^*$ is an infeasible range. Since

the conditions necessary for welfare increase can not be satisfied, this proves our result that any merger arising in this market would reduce social welfare.
Q.E.D.

Bibliography

Cheung, Francis K. (1992) 'Two remarks on the equilibrium analysis of horizontal merger.' *Economics Letters* 40(1), 119–123

Deneckere, Raymond, and Carl Davidson (1985) 'Incentives to form coalitions with bertrand competition.' *RAND Journal of Economics* 16(4), 473–486

Farrell, Joseph, and Carl Shapiro (1990) 'Horizontal mergers: An equilibrium analysis.' *American Economic Review* 80(1), 107–126

Février, Philippe, and Laurent Linnemer (2004) 'Idiosyncratic shocks in an asymmetric cournot oligopoly.' *International Journal of Industrial Organization* 22(6), 835–848

Heubeck, Steven, Donald J. Smythe, and Jingang Zhao (2003) 'The relationship between cost asymmetry and merger efficiency.' Working Paper, Department of Economics, University of Saskatchewan

Kimmel, Sheldon (1992) 'Effects of cost changes on oligopolists' profits.' *Journal of Industrial Economics* 40(4), 441–49

Kovacic, William E., and Carl Shapiro (2000) 'Antitrust policy: A century of economic and legal thinking.' *The Journal of Economic Perspectives* 14(1), 43–60

Lahiri, Sajal, and Yoshiyasu Ono (1988) 'Helping minor firms reduces welfare.' *The Economic Journal* 98(393), 1199–1202

Levin, Dan (1990) 'Horizontal mergers: The 50-percent benchmark.' *American Economic Review* 80(5), 1238–45

Mankiw, N. Gregory, and Michael D. Whinston (1986) 'Free entry and social inefficiency.' *RAND Journal of Economics* 17(1), 48–58

Perry, Martin K., and Robert H. Porter (1985) 'Oligopoly and the incentive for horizontal merger.' *American Economic Review* 75(1), 219–27

Salant, Stephen W., Sheldon Switzer, and Robert J. Reynolds (1983) 'Losses from horizontal merger: The effects of an exogenous change in industry structure on cournot-nash equilibrium.' *Quarterly Journal of Economics* 98(2), 185–99