Merger, Corporate Financing, Managerial Incentives and R & D Effort Duplication*

James H. Cardon
SASAKI Dan

Abstract

We characterize the interplay between oligopolistic firms' strategic decisions in product development, and their incentives for (or against) merger. In an R&D intensive industry where newly developed products can be awarded exclusive patent protection, individual firms' profit maximization can result in effort duplication, which is socially suboptimal. Such strategic incentives can be curtailed by [1] tightening corporate financing, [2] corporate profit taxation, [3] reduction in R&D subsidies, or [4] delegating product development decisions to short-lived managers. The former two ([1] and [2]) also discourage merger. On the other hand, the latter two ([3] and [4]) indirectly encourage merger, as the managerial incentives discouraged away from effort duplication are a consequence of oligopolistic competition, so that the *owners* of these firms have extra incentives toward merger to eliminate competition altogether.

Key Words : patent, clustering, product differentiation.

JEL Classification Numbers : G34, L41, O32.

1. Introduction

The effect of merger between supposedly competing firms in the same industry is twofold. On one hand, it increases concentration, which has a negative effect on welfare unless the merger entails substantial economies of scale. On the other hand, in *product development*, it is believed that cooperation in R&D can enhance efficiency and welfare, by eliminating or reducing *effort duplication*, that is, more than one firm independently engages in development of the same product or the same technology. The argument that such effort duplication is socially wasteful, is not only widely accepted in academic literature, but also

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commonly implemented in policy making[1]. This argument is particularly strong when the end result of R&D is eligible for patent protection, so that only one "winner" (the firm who completes the product or the technology faster than other competing firms) can utilise it as a monopolist.

There is, however, a pitfall in this argument. It deserves very careful attention that so-called R&D effort d has two dimensions.

1. When there is only one product or one technology in question, is it socially efficient for only one firm to develop it, or for more than one firm to compete on its development? (Or more generally, given a fixed set of products or technologies to develop, is it socially efficient if each product is developed by no more than one firm, or if multiple firms compete freely on each product?)
2. Assuming that each firm exerts effort up to a certain fixed R&D capacity, is it socially efficient for multiple firms to develop the same technology or the same product, or to opt for different paths?

The answer to the above 1st question depends largely upon the comparison between the costs of and the social benefits from R&D proliferation, as "duplication" in this sense implies that more firms concurrently exert their effort on each R&D path, i.e., on each product or on each technology to be developed. Hence, no general judgment can be made as to whether duplication in this sense is socially desirable or not. On the other hand, "duplication" in the above 2nd sense is, in normal circumstances[2], unambiguously wasteful especially in the presence of patent protection.

We analyse when, under what conditions, effort duplication in the above 2nd sense occurs endogenously. More specifically, we are interested in [1] when a merger can occur endogenously, and when is it socially desirable[3], as well as [2] when effort duplication can occur between *unmerged* firms. In this paper, we use a simple model of R&D to explore the effects of the following factors on merger and/or R&D effort duplication.

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1) Legal authorities often encourage joint ventures in product development, while they explicitly prohibit market collusion. See the National Cooperative Research Act in the US ; EC Commission (1990) ; and Goto and Wakasugi (1988), *inter alia*.

2) Unless there are synergistic effects from multiple firms' concurrent effort in developing the same product/technology. Such synergies are outside the scope of this paper.

3) Mergers may be motivated not only strategically but also by non-strategic benefit of cost reduction through scale economies or through information pooling between previously rival firms. These effects are, however, highly technology dependent rather than policy dependent and hence are outside of the scope of this paper.

Firstly, corporate financing directly affects the rate of substitution between the initial investment and future profits. Tight corporate financing induces firms' strong time preferences[4], thereby discouraging them from effort duplication. In addition, it can also affect merger decisions : if merger incurs administrative costs (which are often nonnegligible), the repayment of these costs becomes harder when corporate interest rates are high, hence firms are discouraged from merger, too.

Secondly, taxation on corporate profits brings similar effects. Profits from R&D are harvested in the future, as a return on the initial investment. Therefore, as far as the substitution between initial investment costs and future profit gains is concerned, high corporate interest rates and profit taxation have parallel implications : both serving as extra discounting imposed on the future.

Thirdly, subsidization of R&D investment will obviously encourage effort duplication. Therefore, it may seem as if a *reduction* in R&D subsidization might have the same effects as profit taxation. In fact, they both discourage effort duplication. However, there is a difference : profit taxation discourages merger while the reduction in R&D subsidization does not. On the contrary, the latter may indirectly *encourage* merger, because merger will automatically eliminate effort duplication which is now made more costly by the reduction in subsidies.

Finally, it is useful to observe that the decision for or against effort duplication can be made by managers not always by profit-maximising owners, as monitoring of R&D activities is often not trivial. This, in conjunction with the generally stochastic nature of R&D competition, inevitably implies that incentives for or against effort duplication can be affected by the structure of managerial incentives, typically incorporated in the scheme of managerial remunerations. If an *unmerged* firm is run by a highly risk averse manager, then the firm would decide against effort duplication[5], deliberately choosing a distinct R&D path from its competitors which is separately patentable. Such a managerial decision may not optimise the firm's discounted profit. On the other hand, if firms merge, then the room for strategic managerial decisions disappears as far as effort duplication is

4) In this paper we allow the possibility of financial market imperfection, that is, for individual firms to face an interest rate which can differ from *macroeconomic* interest rates. Some of the contributing factors may be industrial policies (subsidized/taxed corporate financing, for instance), and long-term lending relations (such as "main banks"). "Tight corporate financing" refers to high *corporate* interest rates, not necessarily macroeconomic monetary contraction or shortage of aggregate savings.

5) Note that, in the presence of patent protection, effort duplication is a risky strategy since the loser of the race will face the fate of being pre-empted by the winner who monopolises all the reward from the development of the specific product/technology.

concerned. Thereby the presence of strategic managerial incentives——or more precisely, the departure of managerial incentives from corporate profit maximisation——gives the owners of firms an extra incentive for merger. Hence indirectly, these strategic managers are serving to encourage merger.

In all, [1] tight corporate financing, [2] taxation on corporate profits, [3] reducing R&D subsidies, and [4] risk averse managers all serve to discourage effort duplication by *unmerged* firms. However, the former two ([1] and [2]) discourage merger while the latter two ([3] and [4]) encourage merger. Which one of these two directions is socially desirable depends upon the trade-off between the benefits from effort pooling by merger, and those of competition which depends upon the substitutability between different products[6].

In section 2 we build our basic model of competing R&D firms and their strategic product portfolio decisions, assuming that their decisions precisely reflectd expected profit maximization. In section 3, we proceed to a full-fledged model including firm owners' merger decisions. In section 4 we carry out a series of comparative statics exercises to analyse the effects of corporate financing, taxation and subsidization. Then finally, in section 5, we complete our analysis by taking managerial incentives into consideration. Instead of formulating risk aversion after its standard mathematical definitions, we refer to a common practice that managers' office terms are limited within a short period ; much to our curiosity, it turns out that short-lived managers bring similar effects as risk averse managers as far as their product portfolio decisions are concerned. Section 6 provides a brief summary of our results to conclude the paper.

2. When do unmerged firms duplicate R&D?

2.1 The model

Two *a priori* identical firms are entering the same industry. There are two different potential products which, when developed, are separately patentable. The cost of developing a product is C per period, per firm. Assume, for simplicity, that the development of a product takes exactly one period, and that each firm can develop only one product at atime[7].

6) In this paper we avoid technical details on how to model product differentiation, by abstracting profits from underlying demand functions which we leave unspecified in attempt to maintain maximum generality. For concrete modelling details, see Hotelling (1929), d'Aspremont, Gabszewicz and Thisse (1979), Singh and Vives (1984), *inter alia*.

7) To concentrate on product portfolios, we disregard firms' decisions on the *level* of R&D investment. About the interaction between these two aspects, see Cardon and Sasaki (1998) for details.

The time discount factor δ (per period) is common to the two firms.

Firms start development simultaneously. At the end of the first period, each firm completes its first product. If the firms develop two different products, they each register a patent and start selling their products as *duopolists* from the second period onward. We assume for simplicity that exclusive patent protection lasts permanently (see subsection 4.2).

Otherwise, if both firms develop the same product, then each firm has a 50% chance to register a patent on the product and start selling it as a *monopolist* in the second period. At the same time, the two firms compete in developing their second product again. If the previous winner firm wins again, then it will hold monopoly on both products from the third period onward forever, while the loser earns nil. If the former loser wins in the second product, then the firms become duopolists from the third period onward. For simplicity we assume that the probability for the former winner to win the second product is also 50%, although this assumption is inessential for our qualitative findings[8].

As to the product market, to maintain generality we avoid assuming specific demand and cost functions. Instead, we introduce the following notation.

- When two products are supplied by the same firm, then the firm's profit is denoted by Π_{M2}, and the welfare is W_{M2}, both per period (the subscript $M2$ stands for monopoly with two products).
- When two products are supplied by two different firms, then the profit *for each firm* is denoted by Π_D, and the welfare is W_D per period (D for duopoly).
- When there is only one product supplied, the profit is Π_{M1}, and the welfare is W_{M1} per period ($M1$ for monopoly with one product).

Note in general that :

- if the two products are substitutes,

$$\Pi_{M2} \geq \Pi_{M1} > \Pi_D, \qquad W_D > W_{M2} \geq W_{M1} \tag{1}$$

where the equalities hold if and only if the two products are *perfect substitutes* ;

- if the two products are complements,

$$\Pi_{M2} > \Pi_D > \Pi_{M1}, \qquad W_{M2} > W_D > W_{M1}, \tag{2}$$

and that $\Pi_{M2} \geq 2\Pi_D$ irrespective of substitution or complementarity between the products. Throughout this paper we assume that monopoly and oligopoly profits are sufficiently large relative to C, so that firms' participation constraints are always satisfiedand non-binding. Namely, firms continue development as long as there still exists a product not yet patented.

8) If the level of R&D effort is endogenously choosable, then this probability can depend upon the incentives for the former winner and for the former loser to win the second product, respectively, which are determined by the relative differences between Π_{M2}, Π_{M1} and Π_D.

2.2 The profits

For later reference, it is convenient to list the complete streams of profits as follows.

If the two firms develop two different products in the first period, each of them pays C in the first period, and then earns Π_D every period from the second period onwards.

Otherwise, if the two firms *cluster*, i. e., develop the same product in the first period, each firm pays C per period for the first *two periods*. In addition, for each firm there are :

- (Case WW) a 25% chance to be an almighty winner who monopolises both products, earning Π_{M1} in the second period and then Π_{M2} from the third period onwards ;
- (Case WL) a 25% chance to be a winner in the first product but not the second, who earns Π_{M1} in the second period and thenceforth Π_D from the third period ;
- (Case LW) a 25% chance to be a loser in the first product and then win the second, earning nil in the second period but then Π_D from the third period on ;
- (Case LL) a 25% chance to be an eternal loser who sells nil whatsoever.

The following table summarises these profit streams.

Table 1 : expected profit for each individual firm.

period		1	2	≥3	expected discounted sum
no clustering		$-C$	Π_D	Π_D	$-C+\frac{\delta}{1-\delta}\Pi_D$
clustering (with prob. $\frac{1}{4}$ each)	(Case WW)	$-C$	$\Pi_{M1}-C$	Π_{M2}	$-(1+\delta)C+\frac{\delta}{2}\Pi_{M1}+\frac{\delta^2(\Pi_{M2}+2\Pi_D)}{4(1-\delta)}$
	(Case WL)	$-C$	$\Pi_{M1}-C$	Π_D	
	(Case LW)	$-C$	$-C$	Π_D	
	(Case LL)	$-C$	$-C$	0	

2.3 The equilibrium

Insofar as each of the two firms seeks its individual profit maximization, the two firms cluster if and only if

$$-(1+\delta)C+\frac{\delta}{2}\Pi_{M1}+\frac{\delta^2(\Pi_{M2}+2\Pi_D)}{4(1-\delta)} \geq -C+\frac{\delta}{1-\delta}\Pi_D.$$

This can be rewritten as :

Lemma i : The two firms cluster on the same product if

$$C \leq \frac{\Pi_{M1}}{2}-\Pi_D+\frac{\delta}{2(1-\delta)}\left(\frac{\Pi_{M2}}{2}-\Pi_D\right), \tag{3}$$

or diversify over two different products if

$$C \geq \frac{\Pi_{M1}}{2}-\Pi_D+\frac{\delta}{2(1-\delta)}\left(\frac{\Pi_{M2}}{2}-\Pi_D\right), \tag{4}$$

In particular, the following is useful for intuitive interpretation.

Corollary : • As $\delta \uparrow 1$, the two firms always cluster because $\frac{\Pi_{M2}}{2}-\Pi_D \geq 0$.

• As $\delta \downarrow 0$, the two firms cluster if $\frac{\Pi_{M1}}{2}-\Pi_D \geq C$, diversify if $\frac{\Pi_{M1}}{2}-\Pi_D \leq C$.

• The set of parameter values over which the two firms have clustering incentives enlarges as δ increases.

The intuition to this observation is twofold : effort duplicationin R&D is [1] extra initial investment in anticipation for future profit enhancement, and also [2] risky.

2.4 Social implications

If the two firms develop two different products in the first period, the social welfare is $-2C$ in the first period, and then W_D every period from the second period onwards.

Otherwise, if the two firms cluster, the social welfare is $-2C$ in the first period and W_{M1} $-2C$ in the second periods. Then, there are :

- a 50% chance that one firm monopolises both products, yielding the social welfare W_{M2} from the third period onwards (corresponds to Cases WW and LL in subsection 2.2) ;
- a 50% chance the two firms operate as duopolists, selling one product each, yielding the social welfare W_D from the third period onwards (corresponds to Cases WL and LW in 2.2).

These welfare streams can be summarised by the following table.

Table 2 : expected welfare.

period	1	2	≥3	expected discounted sum
no clustering	$-2C$	W_D	W_D	$-2C+\frac{\delta}{1-\delta}W_D$
clustering (prob. $\frac{1}{2}$ each)	$-2C$	$W_{M1}-2C$	W_{M2}	$-2(1+\delta)C+\delta W_{M1}+\frac{\delta^2(W_D+W_{M2})}{2(1-\delta)}$
	$-2C$	$W_{M1}-2C$	W_D	

Hereby from the social point of view, clustering is unambiguously welfare inferior as long as the two products are substitutes. Two firms' diversifying over two different products is socially desirable (see (1) and (2) in subsection 2.1).

Hence, Lemma i implies that the two firms' duopolistic competition in R&D, in conjunction with exclusive patent protection, entails social ineAciency when (3), i.e., when the monopolyduopoly profit differential is substantially large relative to R&D costs.

3. The prospect of merger

Now we formally model the possibility of merger between the two firms. The game involves two *a priori identical* firms as in the previous section, except that they can, if their owners (shareholders) wish, merge into one company. If the firms (their owners) decide

not to merge, then the same game as in section 2 takes place.

Otherwise, if the two firms decide to merge and form one company, then they operate to maximize their *joint* profits. Merger incurs an administrative cost K. This cost is sunk at the very beginning of the game. In the first stage, it is straightforward to verify that the two firms will never cluster under common control (the premise here is that two "firms" remain able to develop two separate products, albeit controlled by one unified "company"). They develop two different products in the first period, and maximize joint profits thereafter. For, being parts of the same company, the two firms no longer need to anticipate duopolistic competition in marketing. Their joint profit per period, from the second period onwards, is simply Π_{M2}.

Hence, the profit and welfare resulting from the merger can be summarised as follows.

Table 3 : profit and welfare after merger.

period	1	≥2	expected discounted sum
profit	$-K-2C$	Π_{M2}	$-K-2C+\frac{\delta}{1-\delta}\Pi_{M2}$
welfare	$-K-2C$	W_{M2}	$-K-2C+\frac{\delta}{1-\delta}W_{M2}$

Note that the two firms must compare this profit with *twice* the individual profits in Table 1 (see subsection 2.2). This implies :

- if two *unmerged* firms would cluster (i.e., inequality (3) in Lemma i), then merger increases the net *aggregate* profit if and only if

$$-K-2C+\frac{\delta}{1-\delta}\Pi_{M2} > -2(1+\delta)C+\delta\Pi_{M1}+\frac{\delta^2(\Pi_{M2}+2\Pi_D)}{2(1-\delta)};$$

- if two *unmerged* firms would diversify (i.e., inequality (4) in Lemma i), then merger increases the net *aggregate* profit if and only if

$$-K-2C+\frac{\delta}{1-\delta}\Pi_{M2} > -2C+\frac{2\delta}{1-\delta}\Pi_D.$$

Simplifying these inequality conditions, we can derive the following.

Proposition I : The two firms merge if and only if either

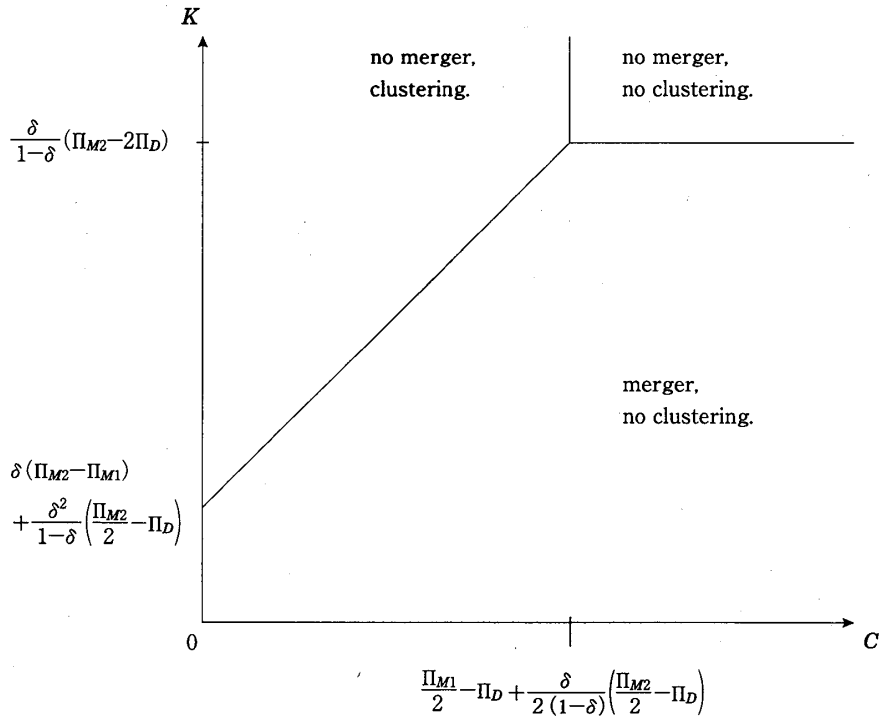
$$(3) \quad \text{and} \quad K < 2\delta C+\delta(\Pi_{M2}-\Pi_{M1})-\frac{\delta^2}{1-\delta}\left(\frac{\Pi_{M2}}{2}-\Pi_D\right)$$

or

$$(4) \quad \text{and} \quad K < \frac{\delta}{1-\delta}(\Pi_{M2}-2\Pi_D).$$

Proposition I is illustrated in Figure 1.

Figure 1 : corporate structure and product portfolios.



4. Policy effects

In this section we proceed to a series of comparative statics exercises. Corporate financing, as well as taxation or subsidization, can affect the discount factor δ, the operative profits Π's from the product market, and the *effective* R&D costs perceived from firms' point of view (even when the *technological* R&D cost C remains unchanged). In the following, we shall discuss the effects of these parameters one by one.

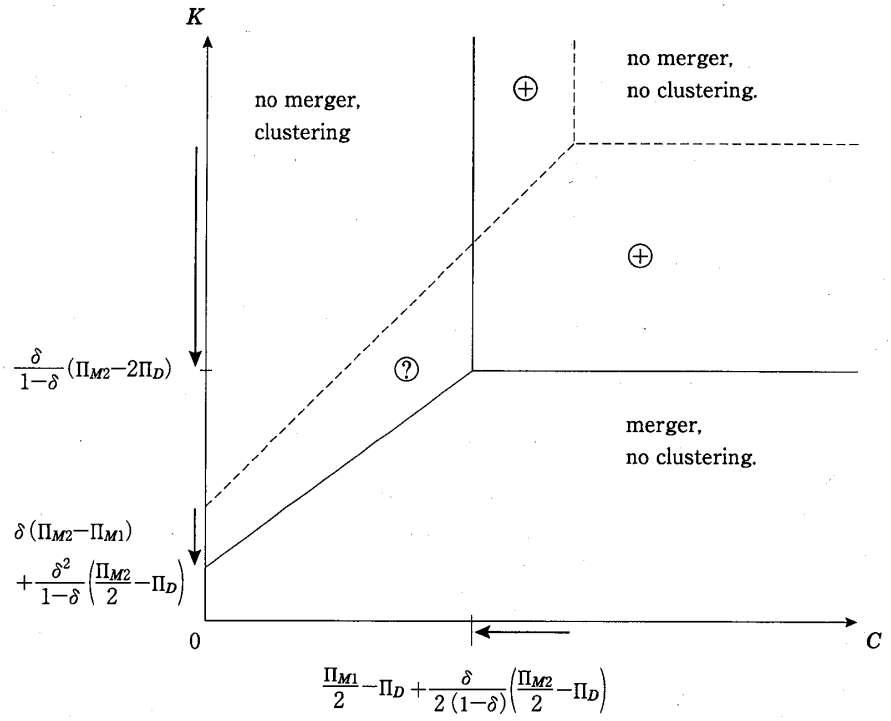
4.1 Corporate financing

The discount factor δ for the firms is affected directly by how much interest the firms are required to pay. It is thereby manipulable either directly by lending them inexpensive loans or indirectly by various regulatory measures, including tax credits[9].

Revisit Proposition I and Figure 1 to observe how a reduction in δ affects our results. Obviously, our analysis here stands upon the proviso that corporate financing must stay within a "reasonable" range where initial costs are still *repayable*. Otherwise, if it became excessively tight, firms' participation conditions would be infringed.

9) Our intention here is to reconfigure the *corporate* discount factor, not the *macroeconomy-wide* discount factor. The latter could affect the computation of welfare and thereby complicate our comparative statics exercise.

Figure 2 : corporate structure and product portfolios as *time preferences vary*.



Tightening corporate financing is socially beneficial in two fronts. A reduction in δ makes the repayment of R&D costs harder, and thereby discourages the firms from clustering. In addition, it also directly discourages the firms from merger, by making the repayment of the initial merger cost K more difficult. This entails an unambiguous social benefit unless the two *unmerged* firms would cluster. We mark these effects with ⊕ in Figure 2.

On the other hand, when the two unmerged firms would cluster in R&D, the trade-off between their effort duplication and their market competition makes the overall social effect unclear. This situation arises over the region marked as ? in Figure 2, mnemonic to the fact that this effect brings an ambiguous incidence to the social total surplus. When (and only when)

$$K > 2\delta C+\delta(W_{M2}-W_{M1})+\frac{\delta^2}{2(1-\delta)}(W_{M2}-W_D),$$

the net effect of this trade-off is socially positive. This occurs when the two products are close substitutes, so that the negative effect of concentration $W_{M2}-W_D$ outweighs the affirmative effect of product diversity $W_{M2}-W_{M1}$.

4.2 Corporate profit taxation

Taxation on firms' profits will affect Π_{M1}, Π_{M2} and Π_D perceived from the firms' point of view. Obviously, it does not affect costs C and K. In particular, if profits are taxed proportionally at a fixed rate (marginal and average rates coincide in this case) t, then it entails

a proportional reduction of Π_{M1}, Π_{M2} and Π_D with the factor $1-t$.

Hence, any alteration in profit taxation has an effect of resizing the whole comparative statics diagram radioprojectively. For instance, if t increases in Figure 1, then the diagram will downsize, rescaling $1-t$ times both horizontally and vertically, thereby the resulting diagram will resemble Figure 2. A similar effect can also be attained by limiting the duration of exclusive patent protection, which helps preserve firms' incentives to stay unmerged/unclustered even when δ is very high. Once again, the tax rate t should not be so high, or the patent duration should not be so short, as to infringe firms' individual rationality constraints.

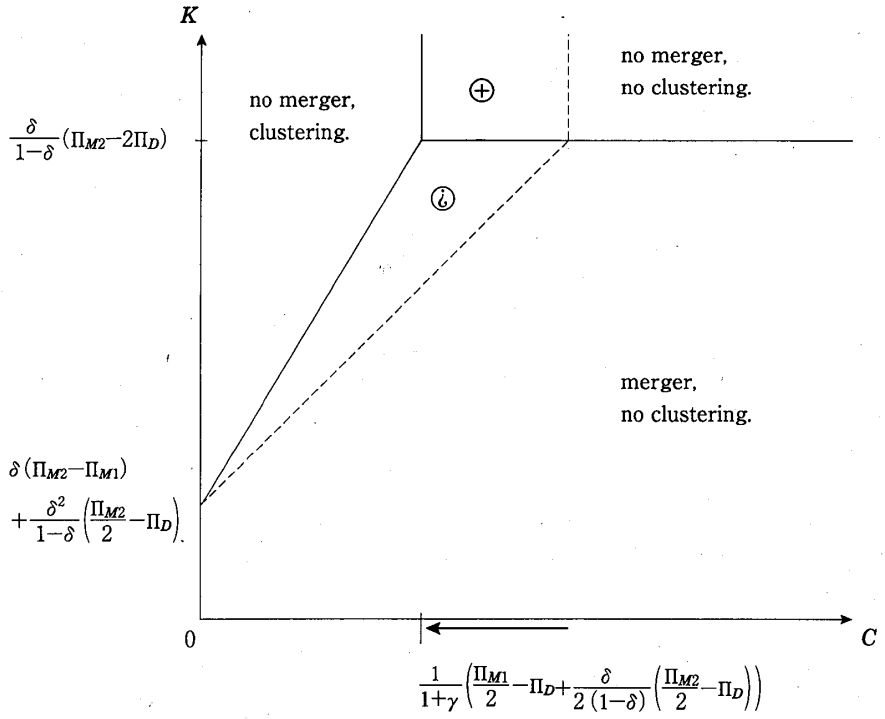
This similarity between a decrease in δ and an increase in t is grounded on the fact that both serve as effective taxation on firms' future profits.

4.3 R&D costs

In many developed economies, it is commonly observed that corporate R&D is entitled to various tax concessions. Hence, the effective costs of R&D from firms' point of view can be inflated (resp., deated) if these tax credits are reduced (resp., enhanced).

Suppose that an alteration in R&D tax/subsidy rules incurs an effect of multiplying the R&D costs by $1+\gamma$ times, perceived from firms' point of view. Keeping the *technological* R&D cost C unchanged, if we replace C with $(1+\gamma)\ C$ in Lemma i and Proposition I, then the comparative statics diagram we obtain, drawn on the *original* $\{C,\ K\}$ plane not on the $\{(1+\gamma)C,\ K\}$ plane, is Figure 3 (the diagram displays the case $\gamma>0$; if $-1<\gamma<0$ the boundaries shift to the right instead of the left). Once again for the sake of comparison, Figure 1 is superimposed in dotted lines.

Figure 3 : corporate structure and product portfolios as *effective R&D costs vary*.



As we observe in the diagram, an alteration in R&D taxation/subsidization does not affect firms' choice between merger and no merger, unless there is a prospect of clustering. On the other hand, $\gamma>0$ makes effort duplication more expensive, thereby discourages clustering. This has a direct positive effect on the social total surplus, illustrated by ⊕ in Figure 3, and also an indirect effect of encouraging merger, indicated by ⓘ which has an ambiguous effect on social welfare.

Note in particular that this indirect effect ⓘ is now opposite from our previous ambiguous effect, marked with ⓘ in Figure 2. Namely, tight corporate financing directly *discourages* merger and thereby indirectly *encourages* clustering, while a reduction in R&D subsidies makes clustering less affordable and thereby indirectly encourages merger.

5. Managerial incentives

Profit-maximizing oligopolists may choose a socially suboptimal R&D portfolio. Now we consider the possibility that firms may behave differently if they are operated by non-shareholding managers whose incentives differ from corporate profit maximization.

As we have shown in section 3, R&D duplication [1] incurs extra initial costs in return for possibly higher future expected profits, and [2] increases risk. Therefore, managerial myopia or risk aversion can serve to curtail clustering incentives. We shall discuss the former in the following subsections 5. 1 and 5. 2, the latter in 5. 3.

5.1 Fixed-term managers

Consider a simple, and by no means unfamiliar, situation where managers are hired on a fixed-term contract and paid proportionally to the corporate profit *only during the contractual term*. This helps examine whether the conventional wisdom, that managerial myopia is a source of social ineAciency as well as corporate profit ineAciency, is theoretically well grounded.

Assume for the time being that managers are inherently risk neutral. Namely, a short-lived manager maximizes the expected discounted profit over the first T periods, where $T \geq 3$ is the length of the managerial term.

Taking these managerial incentives into consideration, we substitute Lemma i with the following.

Lemma ii : Managers of two *unmerged* firms would choose to cluster on the same product if

$$C \leq \frac{\Pi_{M1}}{2} - \Pi_D + \frac{\delta(1-\delta^{T-2})}{2(1-\delta)}\left(\frac{\Pi_{M2}}{2} - \Pi_D\right), \tag{5}$$

or diversify over two different products if

$$C \geq \frac{\Pi_{M1}}{2} - \Pi_D + \frac{\delta(1-\delta^{T-2})}{2(1-\delta)}\left(\frac{\Pi_{M2}}{2} - \Pi_D\right). \tag{6}$$

Since $\Pi_{M2} \geq 2\Pi_D$ in general, this lemma implies that *the shorter the managerial term T, the weaker the managerial incentive for clustering.*

That is, a short-sighted manager is less willing to trade current costs for future benefits, even if the such a trade increases (expected) discounted profits. Note that this Corollary, as well as Corollary of Lemma i, is contrary to our conventional wisdom. As far as product portfolio decisions are concerned, myopic managerial decisions might indeed increase social welfare by curtailing the excess incentives for effort duplication and clustering.

5.2 Effects of managerial myopia

Taking into account the departure of managerial incentives from corporate profit maximization, we can modify Proposition I by replacing conditions (3) and (4) (see Lemma i) respectively with (5) and (6) (see Lemma ii).

Proposition II : The two firms merge if and only if either

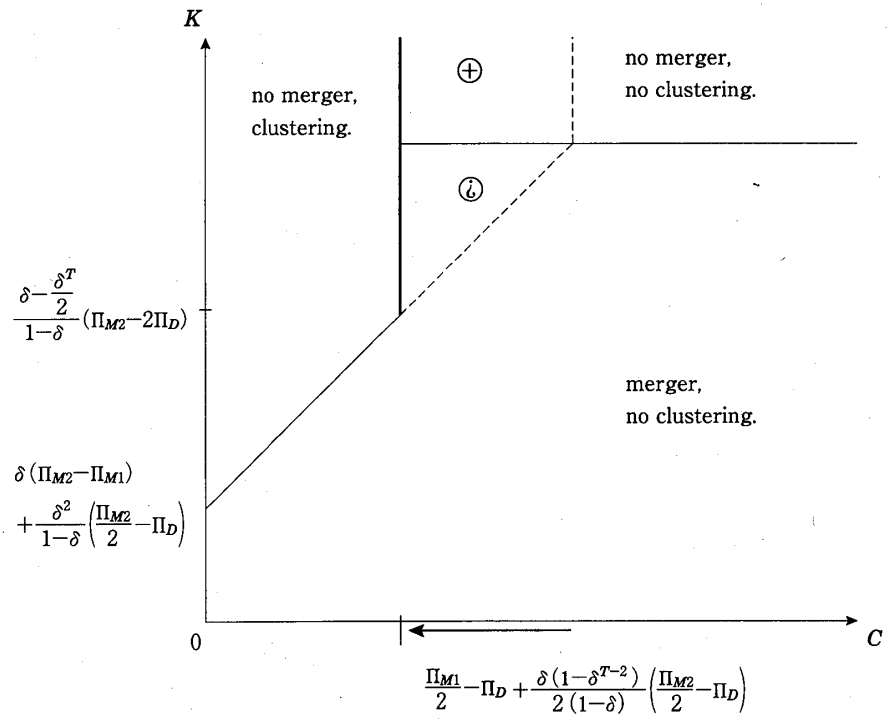
$$(3) \quad \text{and} \quad K < 2\delta C + \delta(\Pi_{M2} - \Pi_{M1}) - \frac{\delta^2}{1-\delta}\left(\frac{\Pi_{M2}}{2} - \Pi_D\right)$$

or

$$(4) \quad \text{and} \quad K < \frac{\delta}{1-\delta}(\Pi_{M2} - 2\Pi_D).$$

This proposition is illustrated in Figure 4. To facilitate the comparison, Figure 1 is superimposed onto Figure 4, using broken lines.

Figure 4: corporate structure and product portfolios with *managerial agency problems.*



As mentioned above, short-lived managers can bring two effects. One is the direct effect of avoiding effort duplication, caused by the managerial incentive to avoid clustering. This direct effect is relevant when the cost of merger K is so high that merger is hardlya viable option. This situation occurs in the region marked as ⊕ in Figure 4, symbolising the fact that this effect is socially aArmative whenever (not only when)

$$W_D-W_{M2}+K>0$$

(see Tables 2 and 3). This inequality is unambiguously satisfied insofar as the two products are substitutes.

The other is the indirect effect of encouraging merger. This effect becomes relevant when both the merger cost K and the product development cost C are intermediate, so that both owners' decisions and managers' decisions are sensitive to the managerial horizon T. Note that this effect, marked with ⓘ in figure 4, is in the same direction as R&D subsidy reduction, opposite from tight corporate financing and profit taxation. Short-lived managers directly avoid clustering and thereby indirectly encourage merger.

As managerial term length T shortens, the thickened vertical border in Figure 4 shifts parallel to the left. Note that, when T is infinity, this thickened border coincides with the vertical broken line, and thereby Figure 4 reduces into Figure 1. This implies that, while T is very long, the area ⓘ is negligibly small, so that the social effect of shortening T can only be affirmative. In contrast, when T is already short, the marginal social effect of

further shortening T becomes ambiguous.

5.3 Extendible-term managers

Another common practice is such that a manager may or may not be re-hired depending upon the level of the firm's profit. Most typically, the re-hiring of the manager is monotone in the profit level during the initial managerial term[10].

Assume that the initial managerial term is $T \geq 3$ periods, and that the manager is expelled at the end of the T-th period if and only if the firm has made net losses over the first T periods. Here, it is easily noticeable that the only case where the manager is to be expelled is when the firm has stayed unmerged, clustered with the other firm, and lost both products (Case LL in subsection 2.2, the bottom row in Table 1). However, in this case, the firm's operative profit beyond the initial managerial term is nil, hence the decision on re-hiring or not re-hiring should be irrelevant to the manager's payoff insofar as the manager is risk neutral. It is straightforward to generalise this intuition : in general, an extendible managerial contract contingent monotonically upon the firm's profits does not necessarily entail the same effects as managerial myopia or risk aversion.

However, as is often the case, if the manager's salary consists of a constant base plus a fixed fraction of the firm's profit, then discontinuation of the contract costs the manager the base salary. This two-part managerial reward, when combined with contingent extension of the managership, can indeed attain a similar effect to managerial risk aversion.

For notational convenience, let this fixed fraction be $\beta \in (0, 1)$ and the base managerial salary be βB per period, so that the whole salary is proportional to B plus the firm's profit as long as the manager remains in office, or nil if the manager is discharged, as is described in. Table 4.

Table 4 : two-part managerial reward.

period	1	2	$3, \cdots, T$	$>T$
no merger, no clustering	$B-C$	$B+\Pi_D$	$B+\Pi_D$	$B\Pi_D$
no merger, clustering (with prob. $\frac{1}{4}$ each)	$B-C$	$B+\Pi_{M1}-C$	$B+\Pi_{M2}$	$B+\Pi_{M2}$
	$B-C$	$B+\Pi_{M1}-C$	$B+\Pi_D$	$B+\Pi_D$
	$B-C$	$B-C$	$B+\Pi_D$	$B+\Pi_D$
	$B-C$	$B-C$	B	0
merger, no clustering	$B-C$	$B+\Pi_{M2}$	$B+\Pi_{M2}$	$B+\Pi_{M2}$

10) In our model it may theoretically be possible to construct a non-monotone contingent contract so as to "force" managers to do precisely what they are "supposed to" do, whether the intended purpose be profit maximization or social optimization. We preclude such artificial schemes from our analysis. The reason why non-monotone contracts are uncommon in reality seems, at least partly, because they are impracticable in that managers would come up with an incentive to waste or "stash" some part of the profits to exploit the non-monotonicity of their contracts.

Now, we obtain the following in lieu of Lemma ii.

Lemma iii : Managers of two *unmerged* firms would choose clustering on the same product if

$$C \leq \frac{\Pi_{M1}}{2}-\Pi_D+\frac{\delta}{2(1-\delta)}\left(\frac{\Pi_{M2}-\delta^{T-2}B}{2}-\Pi_D\right), \tag{7}$$

or diversifying over two different products if

$$C \geq \frac{\Pi_{M1}}{2}-\Pi_D+\frac{\delta}{2(1-\delta)}\left(\frac{\Pi_{M2}-\delta^{T-2}B}{2}-\Pi_D\right). \tag{8}$$

The implications of this lemma are qualitatively similar to those of our previous lemma. The shorter the managerial term T, the weaker the managerial incentive for clustering. This also entails a comparative statics result similar to Proposition II and Figure 4 (see subsection 5. 2).

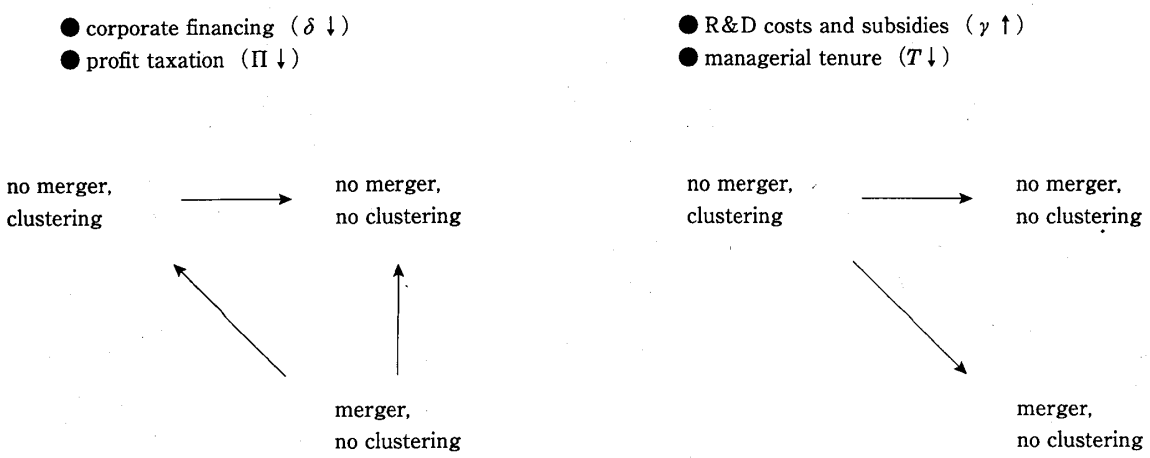
5.4 Summary

As far as effort duplication between *unmerged* firms is concerned, managerial myopia, corporate myopia, profit taxation and reduction in R&D subsidies are all parallel in their effects of discouraging clustering. These effects are socially aArmative without ambiguity.

When the choice is between effort duplication and merger, tight corporate financing and profit taxation tend to discourage merger and thereby to entail *unmerged* firms' effort duplication, while short-lived managers and increased R&D costs have the effect of encouraging merger. As for social implications, clustering is less harmful than merger when the *products are highly substitutable, vice versa* when the products are highly heterogeneous.

These effects are summarised in Figure 5. As the parameters move in the designated direction, the equilibrium tends to move in the direction of the arrows.

Figure 5 : comparative statics effects of



6. Conclusion

In this paper we have used a simple model to characterize the effects of the tightness of corporate financing (parametrised by the corporate discount factor δ), corporate profit taxation (which affects Π's), R&D subsidy or tax credits (parametrised by γ, affecting the effective costs of R&D from the firms' point of view), on the firms' product development decisions and incentives for or against merger. If the corporate discount rate rises (i.e., when δ drops), its direct effect is for managers to avoid clustering as well as for corporate owners to refrain from merger, because the initial costs of R&D and/or merger become harder to repay. We also note that this increased difficulty in merger has an indirect effect of inducing effort duplication between *unmerged* firms when the costs of R&D are relatively low. Similar effects can also be reproduced by corporate profit taxation instead.

In addition, we have contrasted these effects of corporate financing with the effects of managerial incentives. It is often argued that short-term managerial contracts tend to entail an undesirable outcome, both from the viewpoint of profit maximizing corporations and from the social welfare point of view. Namely, a short-lived manager is driven by an incentive to increase short-term profits and thereby fails to make adequate investment for longer-term benefits. This conventional wisdom, whether it upholds or not, is particularly relevant in an industry that requires substantial initial investment such as R&D.

In this paper, we have attempted to clarify the implications of managerial incentives, in the context of an R&D intensive oligopolistic industry. We have shown that short-lived managers' incentives can, under a certain set of conditions, bring an effect of reducing effort duplication in product development and diversifying the product portfolio. Although this effect is directly affirmative from the social point of view, it also brings with it an indirect effect of encouraging merger. As is well known, a merger in an R&D intensive industry has ambiguous effects on social surplus, thereby this indirect effect of managerial incentives has an ambiguous social incidence.

Note finally that the effects of managerial myopia and reduced R&D subsidies are largely parallel. They both have a direct effect of discouraging effort duplication. This effect is similar to the effects of profit taxation and tightened corporate financing. At the same time, myopic managers as well as increased R&D costs have an indirect effect of encouraging merger, simply because effort duplication becomes expensive relative to the costs of merger. This indirect effect is *opposite* from profit taxation and high corporate discount rates.

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