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Strategic merger decisions under environmental corporate social responsibility

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Abstract

This study investigates merger decisions in a green managerial delegation contract with differentiated products and convex production cost, wherein competing multi-product firms can commit to environmental corporate social responsibility (ECSR). We find that ECSR can induce a profitable merger, which may also improve welfare if the production cost efficiency parameter is low and product substitutability is high.

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1. Introduction

As environmental concerns have intensified globally, recent attention has shifted to the formation of firm's strategic adoption of environmental corporate social responsibility (ECSR), which reflects the extent to which firms internalize environmental externalities. Firms with a strong commitment to ECSR voluntarily invest in pollution reduction efforts, even when not strictly required by law, as part of their broader corporate strategies. There are also growing literatures on ECSR in the framework of green managerial delegation contracts (Buccella et al., 2021, 2022, 2023) in the recent literature on industrial organization.[1] Most studies have found that firms internalize social responsibility due to external pressure from governments, supranational organizations, environmental groups, and consumer associations; however, companies can also increase their profits by incorporating social responsibility.

Prior studies on ECSR have mostly focused on single-product competition without considering firms' merger decisions. In the literature on industrial organization, however, mergers with acquisitions between competing firms have become increasingly prevalent over the last decades.[2] Current antitrust enforcement regarding mergers is strictly limited since it may have detrimental effects on competition, and therefore call for antitrust authorities to regulate mergers. However, environmental commitment on ECSR can interact with merger decisions, influencing both environmental and economic performances. Consequently, ECSR has gradually gained increasing attention from researchers and antitrust authorities, sparking antitrust controversies internationally.

A few studies have also examined how differences in externalities control between pre-merger and post-merger markets affect the attractiveness of mergers. Fikru and Gautier (2016) demonstrated that merger could result in lower optimal emission tax post-merger, while Gautier and Fikru (2024) revealed that environmental policy and merger policy could be designed in a synergistic way. Zheng et al. (2021) analyzed whether mergers are helpful for sustainable environmental development through corporate governance. However, they did not pay attention to a question of why firms adopt voluntary ECSR

[1] Some related works include Hirose et al. (2020), Hirose and Matsumura (2022), Xu et al. (2022), Bárcena-Ruiz et al. (2023), Xu and Lee (2024), Xing and Lee (2024a,b), and Kim et al. (2025) among others.

[2] Since Salant et al. (1983) and Levin (1990) initiated the merger paradox, numerous studies have extended various models, especially paying attention to convex production costs in a differentiated products market, showing that mergers are more likely profitable. See Perry and Porter (1985), Lommerud and Sørgard (1997), Heywood and McGinty (2008), and Gelves (2010, 2014) among others. Garcia et al. (2024) provided a summary of related works between CSR decision and merger deals.

under merger deals even without environmental policies.

In this paper, we examine the strategic interaction between firms' merger incentives and ECSR.[3] We consider an industry composed of multi-product and single-product firms that utilize ECSR as a profit-increasing tool and analyze the importance of product differentiation and production cost efficiency. We demonstrate that ECSR can induce profitable merger, which may also improve welfare if the production cost efficiency parameter is low and product substitutability is high.

2. Model and analysis

We consider two differentiated product markets, market A and market B, and in each market multi-product and single-product firms compete to maximize their profits. We refer to the multi-product firm as 'firm 1', providing two products in both markets (A1 and B1), and the single-product firms as 'firm A2' and 'firm B2', providing products in markets A and B, respectively.

Following Dixit (1979) and Singh and Vives (1984), the representative consumer's utility function is defined as follows:

$$U = (q_A + q_B) - \frac{(q_A^2 + 2bq_Aq_B + q_B^2)}{2} + m \tag{1}$$

where $q_k(k = A, B)$ is the total output level of each market; that is, $q_A = q_{A1} + q_{A2}$ and $q_B = q_{B1} + q_{B2}$, $b \in (0, 1)$ measures the degree of product substitutability, and m is the consumption of a numeraire good. The inverse demand function for the market is as follows:

$$p_A = 1 - q_A - bq_B, \quad p_B = 1 - q_B - bq_A \tag{2}$$

where p_k is the price of each market $k(k = A, B)$. Consumer surplus is defined as $CS = U(q_A + q_B) - p_Aq_A - p_Bq_B$.

The production of firms inevitably leads to pollution, in which q_{ki} units of output cause e_{ki} units of emission. Both firms can also reduce emissions by undertaking abatement activities using end-of-pipe technology and, thus, the emission levels of firm *i* in each market is given by the following:

$$e_i = e_{Ai} + e_{Bi} \text{ and } e_{ki} = q_{ki} - x_{ki}, \ i = 1, 2, \ k = A, B. \tag{3}$$

[3] As a complementary work, Garcia et al. (2024) also examined merger decisions by two profit-oriented single product firms when the multiproduct firm adopt CSR, emphasizing the timing of strategic choices between merger and CSR commitment.

where q_{ki} is firm i's output of product $k(k = A, B)$ and $x_{ki} \in [0, q_{ki}]$ is firm i's pollution abatement level of product k. Each firm i sets the pollution abatement level to reduce emissions with a quadratic abatement cost $C(x_{ki}) = \frac{\gamma x_{ki}^2}{2}$, where the parameter γ reflects the efficiency of abatement technology and we set $\gamma = 1$ for analytic simplicity.[4]

Following Garcia et al. (2024), each firm has a convex production cost,[5] i.e., $C(q_{ki}) = \frac{cq_{ki}^2}{2}$, where c represents the coefficient of production cost efficiency. Subsequently, the profit functions of firms are as follows:

$$\pi_i = \pi_{Ai} + \pi_{Bi},\ \pi_{ki} = p_k q_{ki} - \frac{c\, q_{ki}^2}{2} - \frac{x_{ki}^2}{2},\ i = 1, 2,\ k = A, B \tag{4}$$

We use a quadratic functional form to measure the environmental damage by production activities:

$$ED = d(\sum_{i=1}^{2} e_i)^2 \tag{5}$$

where d denotes the government's valuation of marginal environmental damage.

We define social welfare as the sum of consumer surplus, and the producer surplus of multi-product firms and single-product firms minus the environmental damage caused by production processes.

$$W = CS + \sum_{i=1}^{2} \pi_i - ED \tag{6}$$

Finally, we adopt a green managerial delegation model with ECSR (Cho and Lee, 2024; Xing and Lee, 2024), where the owners of multi-product and single-product firms can impose environmental incentives on their managers. That is, firm owners can commit to ECSR in public and then compensate their managers based on their emission levels, which are measured as the level of ECSR. The firm's managers' objective function then becomes the combination of firm's profit and its own emission level.

$$V_i = \pi_i - \beta_i e_i,\ V_{ki} = \pi_{ki} - \beta_{ki} e_{ki},\ i = 1, 2,\ k = A, B. \tag{7}$$

where $\beta_i \in [0,1]$ and $\beta_{ki} \in [0,1]$ represent the degree of ECSR of multi-product and single product firms. It should be noted that $\beta_i = 0$ and $\beta_{ki} = 0$ indicate that firm *i* is a private firm pursuing absolute profits.

The game runs as follows.[6] In the first stage, single-product firms determine whether to merge or

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[4] Supplement B1 shows that as γ increases, welfare-increasing merger is less likely to arise.

[5] Supplement B3 examines constant production costs and finds that welfare-increasing merger always appear unless product substitutability is low.

[6] As suggested in Buccella et al. (2021) and Xing and Lee (2024c), we can construct an endogenous choice model

not. In the second stage, firm owners set the level of ECSR that maximizes their profits. In the final stage, firm managers simultaneously decide their quantities and abatement levels.

The analysis of pre- and post-merger with ECSR is provided in Supplement A, while the equilibrium outcomes are provided in Tables 1 and 2, in which the superscript * denotes 'pre-merger' and the superscript ** denotes 'post-merger'.

[Table 1] Pre-merger equilibrium outcomes

$$\beta_1^* = \frac{(2b^2+3b(2+c)+(2+c)^2)(21+61c+69c^2+38c^3+10c^4+c^5+b^4(1+c)-b^2(22+42c+28c^2+7c^3))}{H_1},$$

$$\beta_{k2}^* = \frac{\{(2+c)((1+c)(2+c)(3+c)-b^2(6+5c))(7+b^3+b^2(7+4c)+c(11+6c+c^2)+b(13+14c+4c^2))\}}{H_1},$$

$$q_1^* = \frac{2(3+b^2+4c+c^2+b(4+3c))(21+61c+69c^2+38c^3+10c^4+c^5+b^4(1+c)-b^2(22+42c+28c^2+7c^3))}{H_1},$$

$$q_{k2}^* = \frac{(7+b^3+11c+6c^2+c^3+b^2(7+4c)+b(13+14c+4c^2))(b^4+(3+4c+c^2)^2-b^2(10+16c+7c^2))}{H_1}.$$

where $H_1 = (273 + b^8 + 1192c + 2224c^2 + 2314c^3 + 1465c^4 + 576c^5 + 137c^6 + 18c^7 + c^8 + 2b^7(5 + 3c) + b^6(22 + 21c + 4c^2) - 2b^5(42 + 93c + 70c^2 + 18c^3) - b^4(438 + 1098c + 1048c^2 + 453c^3 + 75c^4) - b^3(526 + 1522c + 1782c^2 + 1055c^3 + 313c^4 + 36c^5) + b^2(142 + 549c + 814c^2 + 602c^3 + 237c^4 + 48c^5 + 4c^6) + b(600 + 2366c + 3896c^2 + 3473c^3 + 1807c^4 + 547c^5 + 89c^6 + 6c^7))$.

Then, we obtain π_1^*, π_2^*, CS^*, ED^*, and W^* whose lengthy explicit expressions are omitted for the sake of brevity.

[Table 2] Post-merger equilibrium outcomes

$$\beta_i^{**} = \frac{(2+2b+c)^2}{H_2},\ q_{\mathrm{i}}^{**} = \frac{2(1+b+c)(3+3b+c)}{H_2},\ x_{\mathrm{i}}^{**} = \frac{2(2+2b+c)^2}{H_2},$$

where $H_2 = 13 + 9b^3 + 19c + 8c^2 + c^3 + b^2(31 + 15c) + b(35 + 34c + 7c^2)$.

Then, we obtain π_i^{**}, CS^{**}, ED^{**}, and W^{**}.

3. Main findings

We compared the equilibrium results between pre-merger and post-merger in the following:[7]

of ECSR to determine whether to adopt ECSR but we find that firms neither choose merger nor adopt ECSR in this case.

[7] The proofs of propositions are easy and therefore omitted from the main manuscript; however, more detailed analyses are provided in Supplement C.

Proposition 1. $0 < \beta_1^* < \beta_1^{**} = \beta_2^{**} < \beta_{k2}^* < 1$.

Proposition 1 states that (i) both multi-product and single-product firms always adopt ECSR, regardless of merger decisions (i.e., $\beta_i^* > 0$ and $\beta_i^{**} > 0$). This implies that the commitment to ECSR is credible as a collusive device in this game, which can induce higher profits by lowering total industry outputs under ECSR (Hirose et al., 2020). Proposition 1 also shows that (ii) both multi-product and merged single-product firms set the same level of ECSR post-merger (i.e., $\beta_1^{**} = \beta_2^{**}$), due to the symmetry of the firm's organizational structure, which can increase both firms' abatement costs and thus market prices. This implies that there is a cost-price pass-through effect in ECSR between competing firms under strategic complements relations (Lee and Park, 2019). Finally, Proposition 1 shows that (iii) the multi-product firm adopts a higher ECSR post-merger (i.e., $\beta_1^* < \beta_1^{**}$), but the merged single-product firms adopt lower ECSR post-merger (i.e., $\beta_2^{**} < \beta_{k2}^*$).

The economic intuition is as follows:[8] Without a merger, the multi-product firm can internalize the competition effect between the two products and thus, reducing its output, it can set a lower level of ECSR; whereas the single-product firms should commit to a higher level of ECSR to reduce the competition effect. The different levels of optimal ECSR (β_i^*) induce the single-product firm to produce less output than those of the multi-product firm. When a merger occurs, however, both firms can internalize the competition effect and thus they can set the same levels of optimal ECSR (β_i^{**}). Since the competition effect is reduced, the multi-product firm can commit to decrease its output by setting a higher level of ECSR; whereas the merged single-product firms can increase their output by decreasing their ECSR level. As a result, the total industry outputs are lower post-merger.

We then compare the profits pre-merger and post-merger.

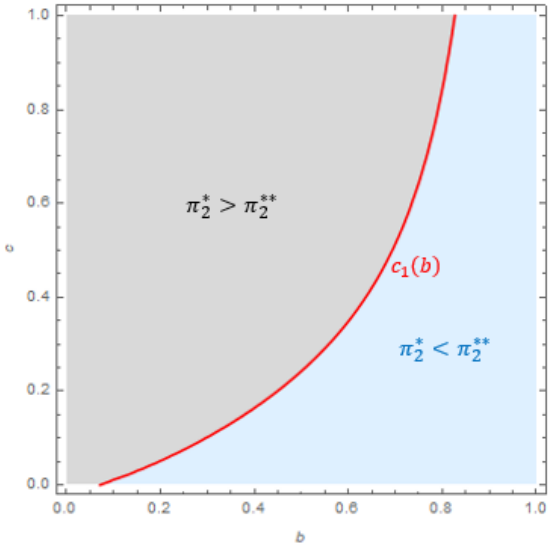
Proposition 2. $\pi_1^* < \pi_1^{**}$ and $\pi_2^* \gtreqless \pi_2^{**}$, if $c \gtreqless c_1(b)$, where $c_1(b)$ satisfies $\pi_2^* = \pi_2^{**}$.

Proposition 2 implies that a merger is always profitable to the multi-product firm, while the merged single-product firms that adopted a lower ECSR can earn more profit than the non-merged case only when the production cost parameter is low and the product differentiation parameter is high.

The economic intuition is as follows: As shown in Proposition 1, the multi-product firm increases its

[8] Note that (i) $q_1^* < q_1^{**} = q_2^{**} < q_2^*$ and $(q_A^* + q_B^*) > (q_A^{**} + q_B^{**})$; (ii) $x_1^* < x_1^{**} = x_2^{**} < x_2^*$ and $(x_1^* + x_2^*) > (x_1^{**} + x_2^{**})$.

level of ECSR post-merger, which can decrease its output due to the increased ECSR, but increase its output because of the merger. Subsequently, the output-decreasing effect with an increased ECSR is outweighed by the output-increasing effect through the merger by the single-product firm. Therefore, the multi-product firm can increase its output while the total industry output decreases post-merger, which is always profitable to the multi-product firm. On the other hand, a merger that reduces the output production of the merged single-product firms is only profitable only when the production technology is efficient while product competition is more intensive. In this case, the market price increasing effect (through reduction of total industry output) can outweigh the output decreasing effect through the merger. This also implies that a commitment to ECSR can serve to form collusion to reduce total output when market competition is fierce. Figure 1 shows that if $c < c_1(b)$, the efficiency gains from cost reductions post-merger can induce a single-product firm to improve its profit. Therefore, a pre-commitment to ECSR can induce a merger by single firms, depending on product substitutability and production cost efficiency.[9] Note that $c_1(b)$ is increasing in b. That is, if the products are more substitutable, higher cost-saving is required to increase the profit of the merged firm.



[Figure 1] Comparison of single-product firm's profits pre-merger and post-merger

Finally, we can evaluate the environmental and welfare performances of the merger decisions. For analytic simplicity, we set $d = 1$ without loss of generality.[10]

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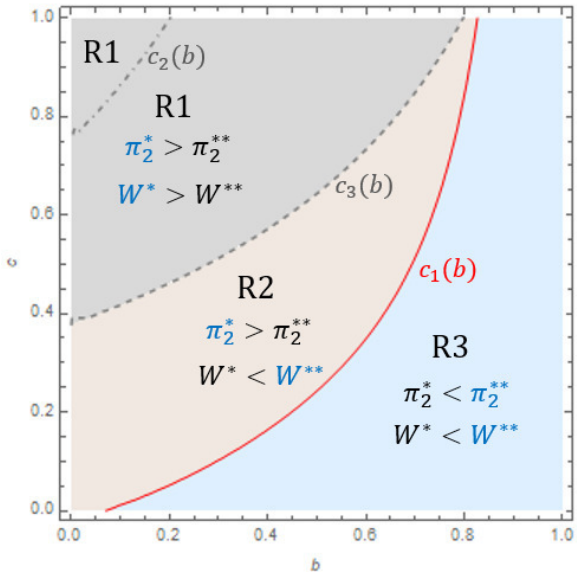
[9] Note that without adopting ECSR, the single-product firms have no incentive to merge and social welfare before the merger is always higher.

[10] Supplement B2 reveals that as d increases, the region R2 where the merger can improve welfare expands.

Proposition 3. (i) $CS^* > CS^{**}$; (ii) $ED^* \lessgtr ED^{**}$ if $c \gtrless c_2(b)$, where $c_2(b)$ satisfies $ED^* = ED^{**}$; (iii) $W^* \gtrless W^{**}$ if $c \gtrless c_3(b)$, where $c_3(b)$ satisfies $W^* = W^{**}$.

Proposition 3 implies that consumer surplus is lower post-merger (due to the reduction of total industry output), whereas the environmental quality can be higher post-merger when the production cost parameter is low or product substitutability is high. In other words, there is a trade-off in welfare comparisons. Figure 2 shows that a lower production cost ensures yields less environmental damage (if $c < c_2(b)$) and higher welfare (if $c < c_3(b)$) since the consumer surplus decreases post-merger. Finally, we can evaluate the private merger incentive by the single-product firms from the viewpoint of social welfare in Figure 2. In Region R1 (if $c > c_3(b)$), no merger occurs which yields higher social welfare post-merger. In Region R2 (if $c_3(b) < c < c_1(b)$), no merger arises while the merger is socially desirable. This indicates that when the production cost is intermediate, it is needed to encourage mergers. In Region R3 (if $c < c_1(b)$), a merger occurs which yields higher social welfare post-merger.



[Figure 2] The merger incentive and social wefare pre-merger and post-merger

4. Concluding remarks

This study investigated merger decisions in an industry composed of multi-product and single-product firms and examined a green managerial delegation contract wherein firm owners can commit to ECSR.

However, if d is sufficiently small, a socially undesirable merger also occurs.

We demonstrate that ECSR can induce profitable merger, which may also improve welfare if the production cost efficiency parameter is low and product substitutability is high.

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