

Research Article

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Corporate Profit Tax and Strategic Corporate Social Responsibility Under Foreign Acquisition

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Abstract: This study investigates government public policies facing competing firms' strategic corporate social responsibility (CSR) activities and finds that the choice of CSR crucially depends on corporate profit tax. We demonstrate that strategic CSR decreases while social welfare increases with corporate tax. When the government grants uniform output subsidies, we show that bilateral CSR leads to a lower CSR level than under unilateral CSR but bilateral CSR is always beneficial to society. However, when the government grants discriminatory output subsidies which yield different levels of unilateral CSR, we show that domestic CSR leads to a lower CSR level than under foreign CSR. In an endogenous CSR choice game, domestic CSR (no CSR) is a Nash equilibrium when corporate tax is low (high) under the uniform subsidy, while foreign CSR could be a Nash equilibrium when corporate tax is low under the discriminatory subsidy.

Keywords: corporate profit tax, corporate social responsibility, endogenous CSR choice game

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1 Introduction

As globalization increasingly prevails, domestic industries in most countries are concentrated by a few large foreign-owned firms, which account for a substantial

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share of aggregate international trade.¹ The acquisition of domestic firms' stocks by those firms is also a widespread, visible phenomenon.² For example, the French automotive company Renault acquired a 36.8% equity stake in Nissan Motor in 1999. There are more recent examples in the global energy, airline, and steel industries in the world. In the last decade, we have witnessed a rapid development of new energy vehicles. According to the electric vehicle world sales database, the world annual sales volume was 10,000 units in 2012, while it quickly increased to two million units in 2018. In particular, China's new energy vehicle sales accounted for 56% of global sales, which can be attributed to the sustainable fiscal subsidies provided by the Chinese government since 2013. As the champion in global energy vehicle sales ranked by OEM group 2018, the American Tesla Motors decided to build factories in China in 2018 to compete with some local new energy vehicle companies, such as BYD, Basic BJEV, et al.

In the process of globalization, on the other hand, the popularity of corporate social responsibility (CSR) by global firms has also grown rapidly in recent years.³ Some practical examples include GE's Ecomagination program, Nestlé's Creating Shared Values, and Unilever's Simple Living Plan. Furthermore, it is becoming more common to suggest global standards of international CSR for global firms. For example, the European Commission promotes CSR in the EU and encourages foreign-owned firms to adhere to international guidelines and principles. The Global Reporting Initiative provides a globally applicable framework for drawing up sustainability reports in accordance with internationally recognized criteria.⁴

Both international acquisitions and CSR activities by foreign-owned firms have now become imperative global business strategies. As they have significant welfare

¹ Bernard et al. (2018) reviewed the shares of aggregate trade in international economics and provided strong evidence in support of interdependencies and complementarities between the margins of foreign-invested global firms and their international participation.

² Alley (1997) described the Japanese and U.S. automotive industries and provided a series of reasons firms acquire passive participation shares in other firms. For more discussion, see Gilo and Spiegel (2004), Barcena-Ruiz and Olaizola (2007), and Halm (2009).

³ Various surveys have confirmed the phenomenon that firms are concerned with CSR, such as KPMG (2013, 2015) and the UN Global Compact-Accenture CEO Study (2010, 2013). For comprehensive discussions on CSR research, see Bénabou and Tirole (2010), Schreck (2011), Kitzmueller and Shimshack (2012), Crifo and Forget (2015), and Kim, Lee, and Matsumura (2019).

⁴ The ISO 26000 guidance on social responsibility was published in 2010, but the updated OECD guidelines for foreign-invested enterprises, and the UN guiding principles on business and human rights, were released in 2011. For comprehensive discussions, see Aaronson (2007), Vidal-Leon (2013), and Xu and Lee (2019).

implications on the design of government policies, recent research on international oligopoly markets with heterogeneous objective functions has analyzed different forms of market competition where profit-maximizing private firms may compete with other private firms that have adopted various CSR activities.⁵ Accordingly, recent theoretical studies have also examined the effect of CSR on tariffs and welfare in international trade, such as Wang, Wang, and Zhao (2012), Chang et al. (2014), Manasakis, Mitrokostas, and Petrakis (2018), Liu, Wang, and Chen (2018), and Xu and Lee (2019). However, these works took the level of CSR as an exogenously given variable that was a normative goal established in the social contract.

From a shareholder's viewpoint, CSR is an instrument of the firm's choice variables to engage in a global business strategy that reflects a management's incentive contracts. For example, Starbucks increases its demand by buying fair-trade coffee and tea, and other firms heavily advertise their organic products. This enhances their reputations and increases the firms' values. Similarly, some foreign-owned firms focus a fair amount of attention on image signaling concerns, and thus provide incentives for employee engagement in community service, which boosts their public relations with local communities and attracts motivated employees in the home country.⁶ Accordingly, recent papers have formulated a model of strategic choice of CSR from the strategic motivation of adopting CSR behaviors, and showed that profit maximization could motivate a firm to engage in CSR.⁷ To our knowledge, however, studies on the foreign-owned firms' strategic utilization of CSR initiatives under international acquisitions and the interactions with governmental policies are limited.

There are several definitions used in the CSR literature, even for the purpose of the profit-maximizing or so-called "business" case.⁸ Moreover, CSR incentive contracts may reflect different corporate governance, resulting from different interest group controls, in which consumer interest is important (Königstein and

5 The heterogeneity of objectives among firms has emerged as an important research topic. Recent research has investigated various aspects of CSR, including horizontal competition, vertical relationships, mergers, environmental concerns, international trade, and more. For recent discussions, see Leal, Garcia, and Lee (2018), Manasakis, Mitrokostas, and Petrakis (2018), Xu and Lee (2019), Lee and Park (2019), Garcia, Leal, and Lee (2018a, 2018b) among others.

6 See Besley and Ghatak (2005), Brekke and Nyborg (2008), and Hong and Kacperczyk (2009).

7 Note that CSR firms can earn higher profits, but a higher degree of CSR might not be beneficial to society. On this point, see Goering (2012), Kopel and Brand (2012), Brand and Grothe (2013, 2015), Liu, Wang, and Lee (2015), Lambertini and Tampieri (2015), Planer-Friedrich and Sahm (2016), Fanti and Buccella (2017), and Hino and Zennyo (2017).

8 Siegel and Vitaliano (2007), Carroll and Shabana (2010), and Withisuphakorn and Jiraporn (2016) provide empirical evidence and surveys on the business case.

Müller 2001; Planer-Friedrich and Sahm 2018). As an interesting case of strategic CSR in a market transaction, we regard consumer surplus as a proxy for CSR, which is widely accepted in the literature.⁹ In this case, the firm with CSR activities is defined as a profit-oriented private firm with a concern for consumer surplus as a CSR initiative.

This paper investigates the strategic relationship between consumer-oriented CSR initiatives and international acquisition, and examines the effect of government policies on strategic CSR. In particular, we address the strategic motivations for CSR arising from the interactions between domestic and foreign-owned firms under government public policies such as corporate profit taxes and (uniform or discriminatory) output subsidies.¹⁰ Interestingly, we show that there exists the strategic effect of corporate profit tax on the strategic CSR and output subsidy policy.¹¹ This finding is important to the policymakers because, in the literature of microeconomics, corporate profit taxes are neutral toward firm behaviors.

In a duopoly model of Cournot competition, we examine the governmental policies facing firms' strategic CSR activities and summarize our findings as follows: First, the strategic level of CSR decreases while social welfare increases with corporate tax. Second, unilateral CSR case in which only one firm adopts CSR leads to a higher level of CSR than that under bilateral CSR case in which both firms adopt CSR. Third, the optimal output subsidy increases with corporate tax while it decreases with foreign penetration, and the optimal output tax is possible when the foreign penetration is high and the corporate tax is low. Fourth, the welfare effects of CSR crucially depend on both corporate profit tax and foreign acquisition, but bilateral CSR always yields the highest welfare irrespective of corporate tax or foreign penetration. Fifth, we consider an endogenous choice game of CSR

9 Many studies formulated CSR initiatives by utilizing a theoretical model in which the private firm adopts consumer surplus as a proxy for its own CSR concerns. Specifically, a CSR initiative combines both profitability and consumer surplus. For example, see Kopel and Brand (2012), Brand and Grothe (2013), Matsumura and Ogawa (2014), Lambertini and Tampiere (2015), Kopel (2015), Leal, Garcia, and Lee (2018), and Garcia, Leal, and Lee (2018a, 2018b), among others.

10 Corporate tax rates substantially differ across countries and foreign-owned firms actively engage in intrafirm transactions across borders. That is, there is a strategic relationship between corporate tax policies and foreign-owned firms' incentive to manipulate strategic practices to avoid tax payments. For example, Gandullia and Pisera (2020) explored empirically the effect of corporate tax on the incentive of CSR in the companies from 15 European countries during 2006–2016, and showed that average effective tax rates are negatively correlated with CSR ratings. See Choi, Furusawa, and Ishikawa (2020) for some policy discussions.

11 It is well known that corporate profit taxes are neutral toward firms' profit-maximizing behaviors. However, Liu, Wang, and Chen (2018) demonstrated a non-zero relationship between a public firm's behavior and corporate taxation policies in a mixed market.

between the two firms and examine the equilibrium choice of CSR. When each firm decides whether to engage in CSR at the beginning of the game, we show that domestic CSR (no CSR) is a Nash equilibrium when corporate tax is low (high). Finally, we consider a discriminatory subsidy where the government grants different subsidies to the firms. We find that foreign CSR (no CSR) is a Nash equilibrium when corporate tax is low (high) in an endogenous choice game of CSR under the discriminatory subsidy; however, neither is socially desirable. Therefore, an appropriate regulatory framework for CSR guidelines is necessary in certain cases with a lower corporate tax.

The remainder of this paper is organized as follows. Section 2 presents the basic model of Cournot competition in which a domestic firm and a foreign-owned firm compete with CSR initiatives under output subsidy and corporate tax policies. We then analyze the market equilibrium under different choices of CSR in Section 3. We then compare the equilibrium outcomes among the four models and extend to an endogenous choice game of CSR in Section 4. In Section 5, we further examine the discriminatory subsidy. Finally, Section 6 concludes the paper.

2 The Model

We consider a duopoly market with two private firms that produce homogeneous products, but with possibly different objectives. Firm 1 and firm 2 are the pure profit-oriented private firms and both of them might engage in CSR activities. We assume that firm 1 is a domestic firm fully owned by domestic investors, while firm 2 is a foreign firm owned by both domestic and foreign investors.¹²

Inverse demand is given by: $p = 1 - Q$, where $Q = q_1 + q_2$ is the market output and q_1 and q_2 denote the quantities supplied by domestic firm 1 and foreign-owned firm 2, respectively. The cost function of firm i is identical and given as: $C(q_i) = \frac{1}{2}q_i^2$, where $i = 1, 2$. The government imposes a corporate profit tax of $\tau \in (0, 1)$ on both firms, which is exogenously given.¹³ Further, the government might provide a

¹² We assume that the foreign-owned firm could be an exclusive foreign-owned enterprise ($\beta = 1$) or a sino-foreign joint venture $\beta \in (0, 1)$, which is the most common method used by multinational corporations that enter the local market.

¹³ PwC reported in 2013 that 95% of countries around the world levy taxes on corporate profits. The report Paying Taxes 2012 showed that, on average, it accounts for 36% of the total tax rate for firms, and more than half of the economies in the world levy a statutory income tax rate between 15 and 30%. As mentioned in Liu, Wang, and Chen (2018), it may be unrealistic to assume that the government can choose a specific corporate tax in a specific industry or market. Thus, we assume that the corporate tax is exogenously given.

production subsidy s per unit of output to the two firms in this market.¹⁴ Note that the output subsidy becomes an output tax when it is negative.

The profits of the firms are as follows:¹⁵

$$\pi_i = (1 - \tau) \left(pq_i - \frac{1}{2} q_i^2 + sq_i \right). \quad (1)$$

It is assumed that each firm maximizes its profit as a pure private firm, and both of them can strategically choose profit-oriented CSRs. In particular, we assume that the firm is in a managerial delegation contract in which output production decisions are delegated to a manager. That is, the owner of the firm specifies a degree of CSR as an incentive contract with the manager to maximize the profit.¹⁶ In this managerial delegation contract, the manager is assumed to maximize the profit of the firm plus a fraction of consumer surplus in output production that is imposed by the owner. Thus, the objective function of the manager of the firm is given as follows:

$$V_i = \pi_i + \alpha_i CS, \quad (2)$$

where $\alpha_i \in [0, 1]$ represents the level of CSR of firm i and $CS = \frac{1}{2}Q^2$ is the consumer surplus. Note that a consumer-friendly CSR initiative is regarded as that the firm adopts consumer surplus as a proxy for its own CSR concerns. Then, the CSR incentive combines profitability and consumer surplus in a convex combination formula. When the firm engaged in CSR assigns a weight to consumer surplus in its objective function, it is sensible to assume that the firm places a higher weight on output, and that it produces aggressively. Here, $\alpha_i = 0$ denotes a pure profit-maximizing private firm. Finally, we take the strategic CSR perspective that the owner strategically chooses its level of CSR in order to maximize its profit π_i in (1). That is, the firms will adopt strategic CSR only when CSR increases its profitability.

14 This assumption is prevalent in reality, such as output subsidies granted to the electric vehicle industry in China. For example, the Chinese government has, since 2013, continued to provide similar subsidies to both local and foreign-owned vehicle firms, including Tesla, LEXUS, and BMW.

15 We can consider the other case, in which the government does not impose corporate profit tax on the subsidy part. That is, direct financial subsidies from the government can be exempted from the corporate tax base. Then, we can formulate the profit function as $\pi_i = (1 - \tau)(p_i q_i - q_i^2/2) + sq_i$, but we can show that main results are the same with those in the current model.

16 In the managerial delegation contract, the firm may strategically use CSR initiative as a commitment device to expand the outputs and thus the firm that adopts CSR obtains higher profits than its profit-seeking competitors. For recent discussion on the theoretical relationship between managerial delegation and CSR, see Lambertini and Tampieri (2015), Lee and Park (2019), and Garcia, Leal, and Lee (2019).

Considering the share of foreign ownership, we define producer surplus as: $PS = \pi_1 + (1 - \beta)\pi_2$, where $\beta \in (0, 1]$ is the foreign penetration in the foreign-owned firm, which can be potentially affected by policymakers acting on capital liberalization.¹⁷ We define domestic welfare as the sum of consumer surplus, producer surplus, and tax revenue, $T = \tau \sum \left(p_i q_i - \frac{1}{2} q_i^2 + s q_i \right)$, minus the subsidy expenditure, $S = s \sum q_i$:

$$W = CS + PS + T - S. \quad (3)$$

This study considers different scenarios regarding the choice of CSR unilaterally or bilaterally under government policies in a certain industry. In particular, when the two firms decide whether to engage in CSR activities or not in the beginning, we classified with four scenarios: “bilateral CSR” where both firms adopt CSR bilaterally, “domestic CSR only” or “foreign CSR only” where either one of two firms adopts CSR unilaterally, and “no CSR” where no firms adopt CSR. In each scenario, the timing of each game is as follows. In the first stage, the government decides the level of output subsidy. In the second stage, given the level of subsidy s , the firm chooses the level of CSR to maximize its own profit.¹⁸ In the final stage, given the level of CSR α_i , both firms compete in quantities. We solve the subgame perfect Nash equilibrium using backward induction.

3 The Analysis

3.1 Bilateral CSR

We consider a bilateral case in which two firms simultaneously engage in CSR activities. In the last stage, both firms choose the outputs. For a domestic firm, the differentiation of V_1 in Eq. (2) with respect to q_1 yields¹⁹

¹⁷ We can interpret the foreign penetration as indicating the level of market openness in financial markets. Thus, we assume that the foreign penetration rate is also exogenously given. See Haraguchi and Matsumura (2014), Xu, Lee, and Matsumura (2017), and Lee, Sato, and Matsumura (2018).

¹⁸ Note that the choice of output subsidy is policy level while CSR choice is strategy level and thus policy is likely to be irreversible and less flexible, compared to the firm's strategy. Further, even though the CSR level can be announced before the subsidy policy, the opportunistic firm can easily change its CSR strategy by observing the output subsidy rate before determining output level. Note that this case provides the same result as the case of simultaneous choice between CSR and subsidies.

¹⁹ It is evident that the second-order conditions for the maximization problems are satisfied among the models.

$$\frac{\partial V_1}{\partial q_1} = (1 - \tau)(1 + s - 3q_1 - q_2) + (q_1 + q_2)\alpha_1 = 0. \quad (4)$$

For a foreign-owned firm, the differentiation of V_2 in Eq. (2) with respect to q_2 yields

$$\frac{\partial V_2}{\partial q_2} = (1 - \tau)(1 + s - q_1 - 3q_2) + (q_1 + q_2)\alpha_2 = 0. \quad (5)$$

From Eqs. (4) and (5), we obtain the following equilibrium outputs:

$$q_1 = \frac{(1 + s)(2 - 2\tau + \alpha_1 - \alpha_2)}{2(4 - 4\tau - \alpha_1 - \alpha_2)} \quad \text{and} \quad q_2 = \frac{(1 + s)(2 - 2\tau - \alpha_1 + \alpha_2)}{2(4 - 4\tau - \alpha_1 - \alpha_2)}. \quad (6)$$

The profits of the domestic and foreign-owned firms are respectively

$$\begin{aligned} \pi_1 &= \frac{(1 + s)^2(1 - \tau)(2 - 2\tau + \alpha_1 - \alpha_2)(6 - 6\tau - 5\alpha_1 - 3\alpha_2)}{8(4 - 4\tau - \alpha_1 - \alpha_2)^2}, \\ \pi_2 &= \frac{(1 + s)^2(1 - \tau)(2 - 2\tau - \alpha_1 + \alpha_2)(6 - 6\tau - 3\alpha_1 - 5\alpha_2)}{8(4 - 4\tau - \alpha_1 - \alpha_2)^2}. \end{aligned} \quad (7)$$

In the second stage, each firm chooses the level of CSR to maximize the profits in (7). The differentiation of π_i in Eq. (7) with respect to α_i yields

$$\alpha_1 = \frac{(1 - \tau - \alpha_2)(2 - 2\tau - \alpha_2)}{11 - 11\tau - 3\alpha_2}, \quad \alpha_2 = \frac{(1 - \tau - \alpha_1)(2 - 2\tau - \alpha_1)}{11 - 11\tau - 3\alpha_1}. \quad (8)$$

Note that the strategic CSR activities can be strategic complements or strategic substitutes, depending on the level of corporate tax, that is, $\frac{\partial \alpha_i}{\partial \alpha_j} > 0$ if

$$\tau \in \left(1 - \frac{(11+2\sqrt{10})\alpha_2}{27}, 1 - \frac{(11-2\sqrt{10})\alpha_2}{27}\right) \quad \text{and} \quad \frac{\partial \alpha_i}{\partial \alpha_j} < 0 \quad \text{otherwise, where } i = 1, 2 \text{ and } i \neq j.$$

This implies that both firms' CSR activities can be strategic substitutes when corporate tax is either low or high while, they are independent of output subsidy and foreign penetration.

Combining two reaction functions in Eq. (8), we have the optimal level of CSR of the firm:

$$\alpha_i^B = \frac{(7 - \sqrt{41})(1 - \tau)}{4}, \quad (9)$$

where superscript "B" represents the equilibrium outcome under **B**ilateral CSR and $i = 1, 2$. From Eq. (9), both firms adopt the same level of CSR where $0 < \alpha_i^B < 1$. That is, both domestic and foreign-owned firms always engage in CSR activities, which decreases with corporate tax rate, for instance, $\frac{\partial \alpha_i^B}{\partial \tau} < 0$. Thus, a higher corporate tax discourages the profit-oriented CSR. However, CSR is independent of output subsidy and foreign penetration, that is, $\frac{\partial \alpha_i^B}{\partial s} = 0$ and $\frac{\partial \alpha_i^B}{\partial \beta} = 0$.

The resulting social welfare is

$$W = \frac{2(1+s)(2\sqrt{41} - 4 - 6s - \beta(\sqrt{41} - 4)(1+s)(1-\tau))}{(1 + \sqrt{41})^2}. \quad (10)$$

In the first stage, the government chooses the level of subsidy to maximize social welfare. The differentiating of W in Eq. (10) with respect to s yields

$$s^B = \frac{\sqrt{41} - 5 - \beta(\sqrt{41} - 4)(1-\tau)}{6 + \beta(\sqrt{41} - 4)(1-\tau)}. \quad (11)$$

Then, we have that $s^B \geq 0$ when $\tau \leq \tau_B = 1 - \frac{21-\sqrt{41}}{25}$. Note that $s^B \geq 0$ if $\beta \in \left[0, \frac{21-\sqrt{41}}{25}\right]$

(since $\tau_B \leq 0$) while $s^B < 0$ if $\beta \in \left(\frac{21-\sqrt{41}}{25}, 1\right]$ and $\tau \in (0, \tau_B)$. Thus, the government taxes the output when the foreign penetration is high and the corporate tax is low enough. Moreover, the optimal output subsidy increases with corporate tax rate, while it decreases with foreign penetration, namely, $\frac{\partial s^B}{\partial \tau} > 0$ and $\frac{\partial s^B}{\partial \beta} < 0$. This implies that subsidy and corporate tax policies are complements, while subsidy and capital liberalization policies are substitutes.

The equilibrium market output and price are

$$Q^B = \frac{4}{6 + \beta(\sqrt{41} - 4)(1-\tau)} \quad \text{and} \quad p^B = \frac{2 + \beta(\sqrt{41} - 4)(1-\tau)}{6 + \beta(\sqrt{41} - 4)(1-\tau)}. \quad (12)$$

Note that the market output increases with corporate tax, while decreases with foreign penetration, for instance, $\frac{\partial Q^B}{\partial \tau} > 0$ and $\frac{\partial Q^B}{\partial \beta} < 0$. Thus, an increase in corporate tax leads to a higher subsidy, increasing the market output, while an increase in foreign in the foreign-owned firm leads to a lower subsidy, decreasing the market output.

The profit of the firm is, respectively

$$\pi_i^B = \frac{2(\sqrt{41} - 4)(1-\tau)}{(6 + \beta(\sqrt{41} - 4)(1-\tau))^2}. \quad (13)$$

Note that the profit of the firm decreases with corporate tax rate and foreign penetration, that is, $\frac{\partial \pi_i^B}{\partial \tau} < 0$ and $\frac{\partial \pi_i^B}{\partial \beta} < 0$. Note that the profits of the two firms are the same since both firms engaged in the same level of CSR at equilibrium, namely, $\pi_1^C = \pi_2^C$.

Finally, the social welfare is

$$W^B = \frac{2}{6 + \beta(\sqrt{41} - 4)(1 - \tau)}. \quad (14)$$

Note that the welfare increases with corporate tax, but decreases with foreign penetration, for instance, $\frac{\partial W^B}{\partial \tau} > 0$ and $\frac{\partial W^B}{\partial \beta} < 0$. In other words, from the view of social welfare, the government intends to improve the rate of corporate tax, but reduce the level of market openness in financial markets.

3.2 Domestic CSR Only

We consider one unilateral case in which only domestic firm engages in CSR activities. In the last stage, substituting $\alpha_2 = 0$ into Eqs. (6) and (7) yield the following profit of the domestic firm:

$$\pi_1 = \frac{(1+s)^2(1-\tau)(2-2\tau+\alpha_1)(6-6\tau-5\alpha_1)}{8(4-4\tau-\alpha_1)^2}. \quad (15)$$

In the second stage, the differentiation of π_1 in Eq. (15) with respect to α_1 yields

$$\alpha_1^D = \frac{2(1-\tau)}{11}. \quad (16)$$

where superscript “D” represents the equilibrium outcome when only Domestic firm engages in CSR activities. From Eq. (16), domestic firm always adopts CSR activities where $0 < \alpha_1^D < 1$, which decreases with corporate tax rate, that is, $\frac{\partial \alpha_1^D}{\partial \tau} < 0$. However, CSR is also independent of output subsidy and foreign penetration, namely, $\frac{\partial \alpha_1^D}{\partial s} = 0$ and $\frac{\partial \alpha_1^D}{\partial \beta} = 0$.

The resulting social welfare is

$$W = \frac{(1+s)(280 - s(182 + 75\beta - 75\beta\tau) - 75\beta(1-\tau))}{882}. \quad (17)$$

In the first stage, the differentiating of W in Eq. (17) with respect to s yields

$$s^D = \frac{49 - 75\beta(1-\tau)}{182 + 75\beta - 75\beta\tau}. \quad (18)$$

From Eq. (18), we have that $s^D \leq 0$ when $\tau \leq \tau_D = 1 - \frac{49}{75\beta}$. Note that $s^D \geq 0$ if $\beta \in [0, \frac{49}{75}]$ (since $\tau_D \leq 0$) while $s^D < 0$ when $\beta \in (\frac{49}{75}, 1]$ and $\tau \in (0, \tau_D)$. Thus, the government taxes the output when the foreign penetration is high and the corporate tax is low

enough. Moreover, the optimal output subsidy increases with corporate tax rate, while it decreases with foreign penetration, for instance, $\frac{\partial s^D}{\partial \tau} > 0$ and $\frac{\partial s^D}{\partial \beta} < 0$.

The equilibrium market output and price are

$$Q^D = \frac{121}{182 + 75\beta - 75\beta\tau} \quad \text{and} \quad p^D = \frac{61 + 75\beta - 75\beta\tau}{182 + 75\beta - 75\beta\tau}. \quad (19)$$

Note that the market output increases with corporate tax, while it decreases with foreign penetration, that is, $\frac{\partial Q^D}{\partial \tau} > 0$ and $\frac{\partial Q^D}{\partial \beta} < 0$.

The profit of the firm is respectively

$$\pi_1^D = \frac{5082(1 - \tau)}{(182 + 75\beta - 75\beta\tau)^2} \quad \text{and} \quad \pi_2^D = \frac{9075(1 - \tau)}{2(182 + 75\beta - 75\beta\tau)^2}. \quad (20)$$

Note that the profit of the firm decreases with corporate tax rate and foreign penetration, namely, $\frac{\partial \pi_i^D}{\partial \tau} < 0$ and $\frac{\partial \pi_i^D}{\partial \beta} < 0$. In addition, note that domestic firm engaged in CSR only always earns more profit than that of the foreign-owned firm under the output subsidy, for instance, $\pi_1^D > \pi_2^D$. This is why the domestic firm has an incentive to engage in CSR activities when the foreign-owned firm does not adopt CSR.

Finally, the social welfare is

$$W^D = \frac{121}{2(182 + 75\beta - 75\beta\tau)}. \quad (21)$$

Note that the welfare increases with corporate tax, but it decreases with foreign penetration, that is, $\frac{\partial W^D}{\partial \tau} > 0$ and $\frac{\partial W^D}{\partial \beta} < 0$.

3.3 Foreign CSR Only

We consider the other unilateral case in which only foreign-owned firm engages in CSR. In the last stage, substituting $\alpha_1 = 0$ into Eqs. (6) and (7) yields the following profit of the foreign-owned firm:

$$\pi_2 = \frac{(1 + s)^2 (2 + \alpha - 2\tau) (1 - \tau) (6 - 5\alpha - 6\tau)}{8(4 - \alpha - 4\tau)^2}. \quad (22)$$

In the second stage, the differentiation of π_2 in Eq. (22) with respect to α_2 yields

$$\alpha_2^F = \frac{2(1 - \tau)}{11}, \quad (23)$$

where superscript “ F ” represents the equilibrium outcome when only Foreign-owned firm engages in CSR activities. From Eq. (23), foreign-owned firm always engages in CSR where $0 < \alpha_2^F < 1$. Note that the strategic levels under the unilateral CSR are the same, namely, $\alpha_2^F = \alpha_1^D$, and it also decreases with corporate tax rate, but is independent of output subsidy and foreign penetration.

The resulting social welfare is

$$W = \frac{(1+s)(20-13s-6\beta-6s\beta+6\beta\tau+6s\beta\tau)}{63}. \quad (24)$$

In the first stage, the differentiating of W in Eq. (24) with respect to s yields

$$s^F = \frac{7-12\beta(1-\tau)}{2(13+6\beta-6\beta\tau)}. \quad (25)$$

From Eq. (25), we have that $s^F \leq 0$ when $\tau \leq \tau_F = 1 - \frac{7}{12\beta}$. Note that $s^F \geq 0$ if $\beta \in \left[0, \frac{7}{12}\right]$ (since $\tau_F \leq 0$), while $s^F < 0$ when $\beta \in \left(\frac{7}{12}, 1\right]$ and $\tau \in (0, \tau_F)$. That is, the government taxes the output when the foreign penetration is high and the corporate tax is low enough. Moreover, the optimal subsidy increases with corporate tax rate, while it decreases with foreign penetration.

The resulting market output and price are

$$Q^F = \frac{121}{14(13+6\beta-6\beta\tau)} \quad \text{and} \quad p^F = \frac{61+84\beta(1-\tau)}{14(13+6\beta-6\beta\tau)}. \quad (26)$$

Note that the market output increases with corporate tax, while it decreases with foreign penetration.

The profits of the firms are respectively

$$\pi_1^F = \frac{9075(1-\tau)}{392(13+6\beta-6\beta\tau)^2} \quad \text{and} \quad \pi_2^F = \frac{363(1-\tau)}{14(13+6\beta-6\beta\tau)^2}. \quad (27)$$

Note that the profits of firms decrease with corporate tax rate and foreign penetration. In addition, note that foreign-owned firm engaged in CSR only always earns more profit than that of the domestic firm under the output subsidy, for instance, $\pi_1^F < \pi_2^F$. This is why the foreign-owned firm has an incentive to engage in CSR activities when the domestic firm does not adopt CSR.

Finally, the social welfare is

$$W^F = \frac{121}{28(13+6\beta-6\beta\tau)}. \quad (28)$$

Note that social welfare increases with corporate tax but decreases with foreign penetration.

3.4 No CSR

We finally consider a case in which no firm engages in CSR. In the last stage, substituting $\alpha_i = 0$ into Eq. (6), we can obtain the output of the two firms. Thus, the resulting social welfare is:

$$W = \frac{(1+s)(20-13s-6\beta-6s\beta+6\beta\tau+6s\beta\tau)}{63}. \quad (29)$$

In the first stage, the differentiating of W in Eq. (29) with respect to s yields

$$s^N = \frac{2-3\beta(1-\tau)}{3(2+\beta-\beta\tau)}, \quad (30)$$

where superscript “ N ” represents the equilibrium outcome when **No** firm engages in CSR activities. From Eq. (30), we have that $s^N \underset{>}{\leq} 0$ when $\tau \underset{>}{\leq} \tau_N = 1 - \frac{2}{3\beta}$. Note that $s^N \geq 0$ if $\beta \in [0, \frac{2}{3}]$ (since $\tau_N \leq 0$) while $s^N < 0$ when $\beta \in (\frac{2}{3}, 1]$ and $\tau \in (0, \tau_N)$. Thus, the government taxes the output when the foreign penetration is high and the corporate tax is low enough. Moreover, the optimal output subsidy increases with corporate tax rate, while it decreases with foreign penetration.

The equilibrium market output and price are

$$Q^N = \frac{4}{6+3\beta-3\beta\tau} \quad \text{and} \quad p^N = \frac{2+3\beta-3\beta\tau}{6+3\beta-3\beta\tau}. \quad (31)$$

Note that the market output increases with corporate tax, while it decreases with foreign penetration.

The profit of the firm is respectively

$$\pi_1^N = \pi_2^N = \frac{2(1-\tau)}{3(2+\beta-\beta\tau)^2}. \quad (32)$$

Note that the profit of the firm decreases with corporate tax rate and foreign penetration.

Finally, the social welfare is

$$W^N = \frac{2}{6+3\beta-3\beta\tau}. \quad (33)$$

Note that the welfare increases with corporate tax, but it decreases with foreign penetration.

4 Comparisons and Discussions

4.1 Comparisons

We first compare the results in each equilibrium and provide some findings on the strategic levels of CSR and relations with government policies.²⁰

Proposition 1: *The unilateral CSR leads to a higher level of CSR than that under bilateral CSR.*

Proposition 1 states that the competitive choice of strategic CSR in which both firms engage in CSR activities simultaneously leads to a lower level of CSR than the unilateral case in which only one firm engages in CSR activities. This is because the firm that engages in CSR can be more aggressive and thus can produce more output to enlarge its market share and improve its profit under quantity competition. However, this effect softens when the rival firm also adopts CSR to increase output, which will produce too much output thereby flooding the market.

Proposition 2: *The strategic CSR decreases with corporate tax, while it is independent of output subsidy and foreign penetration.*

Proposition two states that under a higher corporate tax, both firms choose a lower level of CSR and produce less output, that is, there is a negative relationship between CSR strategy and corporate tax policy.²¹ This result implies that the corporate tax can affect market outcomes, which might distort allocation efficiency through output production in the presence of strategic CSR. This is an interesting policy finding. In the previous literature without CSR, it is well known that corporate tax is neutral to the firm's product strategy in the market; and thus, allocation efficiency is independent of corporate tax rate. However, the corporate tax policy is crucial for the government to improve welfare when the firm can choose the level of CSR strategically. On the other hand, the subsidy policy does not affect the decision of CSR for the firms. This result is also interesting in that the firm's strategic decision of CSR to increase the output is neutral to the government's subsidy policy to encourage the firms to produce more output. This implies

²⁰ The proofs of lemmas are presented in the Appendix, while the propositions are simple and thus omitted.

²¹ That result is consistent with recent empirical findings that average effective corporate tax rates are negatively correlated with CSR ratings. For more discussion, see Gandullia and Pisera (2020) and works cited therein.

that the output subsidy policy has a direct effect on the output, but does not have an indirect effect on the output through CSR strategies.

Proposition 3: (i) *The optimal output subsidy increases with corporate tax and decreases with foreign penetration;* (ii) *The output tax is optimal when the foreign penetration is high and corporate tax is low enough.*

The first part of Proposition 3 represents that the output subsidy and corporate tax policies are complements; an increase in corporate tax leads to a higher output subsidy at equilibrium. However, the government's policies between output subsidy and foreign ownership are strategic substitutes: an increase in foreign penetration leads to a lower domestic surplus, thus resulting in a lower subsidy at equilibrium. The second part of Proposition 3 indicates that when the foreign investors become major stakeholders of the foreign-owned firm, but the corporate tax rate is low, the government can impose an output tax on the firm, instead of subsidy. Since the foreign-owned firm with a higher foreign penetration (more than 50%) does not contribute to the producer surplus when the corporate tax is low enough, the government has to shrink the quantities produced by the foreign-owned firm by charging a negative output subsidy.

Lemma 1: *The ranks of optimal output subsidies among the four models are as follows:*

- (i) $0 > s^D \geq s^N > s^B > s^F$ when $0 < \tau \leq \tau_1$;
- (ii) $s^N > s^D > s^B \geq s^F$ when $\tau_1 < \tau \leq \tau_2$;
 - (ii-1) $0 \geq s^N > s^D > s^B > s^F$ when $\tau_1 < \tau \leq \tau_N$;
 - (ii-2) $s^N > 0 \geq s^D > s^B > s^F$ when $\tau_N < \tau \leq \tau_D$;
 - (ii-3) $s^N > s^D > 0 \geq s^B > s^F$ when $\tau_D < \tau \leq \tau_B$;
 - (ii-4) $s^N > s^D > s^B > 0 \geq s^F$ when $\tau_B < \tau \leq \tau_F$;
 - (ii-5) $s^N > s^D > s^B \geq s^F > 0$ when $\tau_F < \tau \leq \tau_2$;
- (iii) $s^N > s^D > s^F > s^B > 0$ when $\tau_2 < \tau < 1$.

Lemma 1 shows the policy relationships between the output subsidy and corporate tax rates. Then, we can summarize the findings in Lemma 1 as follows: (a) $\min\{s^D, s^N\} > \max\{s^B, s^F\}$, (b) $s^D < s^N$ when $\tau < \tau_1$, and (c) $s^B < s^F$ when $\tau < \tau_2$. We will

provide some explanations on the three summaries. First, (a) either domestic CSR or no CSR is always higher than bilateral CSR and foreign CSR. This indicates that the cases without foreign CSR require the government to provide a higher output subsidy than the cases with foreign CSR. For example, we have that $s^D > s^F$ even though the levels of CSR under domestic CSR and foreign CSR are the same. This is because the profit of the foreign-owned firm could be a channel of welfare leakage to the foreign investors, which may lead the government to provide lower subsidy under foreign CSR.

Second, (b) domestic CSR requires a higher subsidy when the corporate tax is low, while no CSR requires a higher subsidy when the corporate tax is relatively high. In particular, when the corporate tax is low enough, namely, $0 < \tau < \tau_1 < \tau_N$, we have that $s^N < s^D < 0$. Thus, the government imposes an output tax on both firms where that under no CSR is higher than that under domestic CSR. Moreover, we have that $s^N \geq 0 > s^D$ when $\tau_N \leq \tau < \tau_D$. That is, when the corporate tax is intermediate, the government imposes an output tax on two firms under domestic CSR and provides an output subsidy to two firms under no CSR. However, when the corporate tax is high enough, for instance, $\tau_D \leq \tau < 1$, we have that $s^N > s^D \geq 0$. Thus, the government provides an output subsidy to both firms where that under no CSR is higher than that under domestic CSR.

Finally, (c) bilateral CSR requires a higher subsidy when the corporate tax is low, while foreign CSR requires a higher subsidy when the corporate tax is relatively high. In particular, when the corporate tax is low enough, that is, $0 < \tau \leq \tau_2$, we have that $s^F < s^B < 0$. Thus, the government imposes an output tax on both firms where that under foreign CSR is higher than that under bilateral CSR. However, when the corporate tax is high enough, namely, $\tau_2 < \tau < 1$, we have that $s^F > s^B > 0$. Thus, the government provides an output subsidy to both firms where that under foreign CSR is higher than that under bilateral CSR.

Proposition 4: *The social welfare increases with corporate tax and decreases with foreign penetration.*

Proposition 4 states that an increase in corporate tax leads to higher levels of subsidy and market output, resulting in higher consumer surplus, subsidy expenditure, and tax revenue, while it reduces two firm's profits. The former effect outweighs the latter effect and thus, an increase in corporate tax makes the society better off. On the other hand, an increase in foreign penetration works negatively in both the former and the latter effects and thus, resulting in lower social welfare.

Lemma 2: *The welfare ranks among the four models are as follows:*

- (i) $W^B > W^D > W^F \geq W^N$ when $0 < \tau \leq \tau_5$;
- (ii) $W^B > W^D \geq W^N > W^F$ when $\tau_5 < \tau \leq \tau_6$;
- (iii) $W^B > W^N > W^D > W^F$ when $\tau_6 < \tau < 1$.

Lemma 2 shows the relationship between the welfare and corporate tax rate. Then, we can summarize the findings in Lemma 2 as follows: (a) $W^B > \max\{W^D, W^F, W^N\}$, (b) $W^D > W^F$, (c) $W^F \leq W^N$ when $\tau \leq \tau_5$, and (d) $W^D \leq W^N$ when $\tau \leq \tau_6$. We will provide some explanations on the four summaries. First, (a) bilateral CSR always yields the highest welfare irrespective of government policies including output subsidy, corporate tax, or open policy on foreign penetration. This is because bilateral CSR yields the largest market output at equilibrium, for instance, $Q^B > \max\{Q^D, Q^F, Q^N\}$, and thus it leads to the highest consumer surplus among the four models.

Second, (b) domestic CSR yields a higher welfare than that under foreign CSR, even though the strategic levels of CSR are the same. This is because the market output will be higher under domestic CSR, that is, $Q^D > Q^F$, since the government provides a higher subsidy, $s^D > s^F$, from Lemma 1. Thus, the less leakage of the welfare under the domestic CSR leads to a higher welfare at equilibrium.

Third, (c) foreign CSR yields a higher welfare when the corporate tax is low, while no CSR yields a higher welfare when the corporate tax is relatively high. Thus, there exists a trade-off between the foreign CSR and no CSR depending on corporate tax rate. Note that no CSR provides a higher subsidy when the corporate tax is relatively high, we have $Q^F \leq Q^N$ when $\tau \leq \tau_5$. Thus, the welfare effect of a higher CSR by the foreign-owned firm and that of a higher output subsidy under no CSR yields the welfare trade-off between the two models.

Finally, (d) domestic CSR yields a higher social welfare when the corporate tax is low, while no CSR yields a higher welfare when the corporate tax is relatively high. There is also a trade-off between domestic CSR and no CSR, but the threshold is higher under domestic CSR. Note that no CSR provides a higher subsidy when the corporate tax is relatively high, we have $Q^D \leq Q^N$ when $\tau \leq \tau_6$. Again, the welfare effect of a higher CSR by the domestic firm and that of a higher output subsidy under no CSR yields the welfare trade-off between the two models.

4.2 Endogenous CSR Choice Game

We then offer an extended game in which we consider an endogenous choice of CSR between the two firms. Before examining CSR choice game, we compare the profits of the two firms in each game.

Lemma 3: *The profit ranks among the four models are as follows:*

- (i) $\pi_2^N > \pi_2^F > \pi_2^D > \pi_2^B$ when $0 < \tau < 1$;
- (ii) $\pi_1^D \geq \pi_1^N > \pi_1^B > \pi_1^F$ when $0 < \tau \leq \tau_3$;
- (iii) $\pi_1^N > \pi_1^D > \pi_1^B \geq \pi_1^F$ when $\tau_3 < \tau \leq \tau_4$;
- (iv) $\pi_1^N > \pi_1^D > \pi_1^F > \pi_1^B$ when $\tau_4 < \tau < 1$.

Lemma 3 shows the relationship between the profits of the two firms and corporate tax rate. It states that (i) the foreign-owned firm always obtains the highest profit under no CSR, compared to other CSR cases including foreign CSR, irrespective of the corporate tax, while it earns a higher profit under foreign CSR than that under bilateral CSR. This is because, although no CSR strategy yields relatively smaller output, $q_2^F > q_2^B > q_2^N > q_2^D$, the government provides a higher subsidy for a large range, as shown in Lemma 1, namely $s^N > \max\{s^B, s^F\}$, and $s^N > s^D$ when $\tau_1 < \tau < 1$.

On the other hand, (ii) states that the domestic firm could obtain the highest profit under domestic CSR only when the corporate tax is relatively low. In particular, we can summarize the findings in Lemma 3 (ii)–(iv) as follows: (a) $\min\{\pi_1^D, \pi_1^N\} > \max\{\pi_1^B, \pi_1^F\}$, (b) $\pi_1^D \leq \pi_1^N$ when $\tau \leq \tau_3$ while $\pi_1^B \leq \pi_1^F$ when $\tau \leq \tau_4$. It shows that (a) the profit of domestic firm is always higher without foreign firm's CSR, irrespective of the corporate tax, while the relative profit between the cases without and with foreign firm's CSR depends on corporate tax. Note that domestic CSR always yields the largest output of the domestic firm, for instance, $q_1^D > q_1^B > q_1^N > q_1^F$ while $s^N > s^D > 0 > s^B > s^F$ when the corporate tax is low, that is, $0 < \tau \leq \tau_3$. That is, the government provides output subsidy to the domestic firm under no CSR and domestic CSR, and imposes an output tax under bilateral CSR and foreign CSR when the corporate tax is low. It represents that (b) the domestic firm could benefit from (not) adopting CSR when the corporate tax rate is low (high) irrespective of whether the foreign firm adopts CSR or not. In particular, the domestic firm (not) adopting CSR could obtain the highest profit when the corporate tax is low (high).

Finally, we consider an extensive game with endogenous choice of CSR in which each firm decides whether to engage in CSR activities or not simultaneously and non-cooperatively before the first stage of the previous analysis. Then, we have an endogenous CSR choice game in Table 1.

Then, from Lemma 3(i), we have that $\pi_2^D > \pi_2^B$ and $\pi_2^N > \pi_2^F$. This implies that the dominant strategy for the foreign-owned firm is no CSR. Further, from Lemma 3(ii) and (iii), we have $\pi_1^D \leq \pi_1^N$ when $\tau \leq \tau_3$. Thus, we can show that the equilibrium of an endogenous choice of CSR between the firms depends on the corporate tax rate and foreign penetration.

Proposition 5: *Domestic CSR (no CSR) is a Nash equilibrium when the corporate tax is low (high), however neither one is socially desirable.*

Proposition 5 shows that domestic CSR is a Nash equilibrium when τ is low, namely $0 < \tau < \tau_3$, while no CSR is a Nash equilibrium when τ is high, for instance, $\tau_3 < \tau < 1$. Moreover, both domestic CSR and no CSR are the Nash equilibria when $\tau = \tau_3$. However, Lemma 2 reveals that neither of the Nash equilibria is socially desirable. Therefore, an appropriate regulatory framework for CSR guidelines is necessary in certain cases with a lower corporate tax and a higher foreign penetration.

5 Discriminatory Subsidy

We now consider a discriminatory subsidy according to which the government grants different levels of output subsidies to the firms, s_i , in the first stage. The profit of the firm is $\pi_i = (1 - \tau)(pq_i - \frac{1}{2}q_i^2 + s_iq_i)$, and the total subsidy expenditure is $S = s_i \sum q_i$ where $i = 1, 2$. For simple comparisons, we assume that $\beta = 1$ where the foreign-owned firm is an exclusive foreign-owned enterprise. In the below, we analyze the four models under discriminatory subsidies, respectively, and then examine an endogenous choice game of CSR.

Table 1: Endogenous CSR choice game under uniform subsidies.

Firm 1, 2	CSR	No CSR
CSR	π_1^B, π_2^B	π_1^D, π_2^D
No CSR	π_1^F, π_2^F	π_1^N, π_2^N

First, we consider a bilateral CSR case. In the last stage, the differentiation of V_i with respect to q_i yields the following outputs:

$$\begin{aligned} q_1 &= \frac{2 - 2\tau + 3s_1 - 3\tau s_1 - s_2 + \tau s_2 + \alpha_1 + s_2\alpha_1 - \alpha_2 - s_1\alpha_2}{2(4 - 4\tau - \alpha_1 - \alpha_2)}, \\ q_2 &= \frac{2 - 2\tau - s_1 + \tau s_1 + 3s_2 - 3\tau s_2 - \alpha_1 - s_2\alpha_1 + \alpha_2 + s_1\alpha_2}{2(4 - 4\tau - \alpha_1 - \alpha_2)}. \end{aligned} \quad (34)$$

The profits of the domestic and foreign-owned firms are respectively

$$\begin{aligned} \pi_1 &= \frac{(1 - \tau)(2 - 2\tau + 3s_1 - 3\tau s_1 - s_2 + \tau s_2 + \alpha_1 + s_2\alpha_1 - \alpha_2 - s_1\alpha_2) \\ &\quad (6 - 6\tau + 9s_1 - 9\tau s_1 - 3s_2 + 3\tau s_2 - 5\alpha_1 - 4s_2\alpha_1 - s_2\alpha_1 - 3\alpha_2 - 3s_1\alpha_2)}{8(4 - 4\tau - \alpha_1 - \alpha_2)^2}, \\ \pi_2 &= \frac{(1 - \tau)(2 - 2\tau - s_1 + \tau s_1 + 3s_2 - 3\tau s_2 - \alpha_1 - s_2\alpha_1 + \alpha_2 + s_1\alpha_2) \\ &\quad (6 - 6\tau - 3s_1 + 3\tau s_1 + 9s_2 - 9\tau s_2 - 3\alpha_1 - 3s_2\alpha_1 - 5\alpha_2 - s_1\alpha_2 - 4s_2\alpha_2)}{8(4 - 4\tau - \alpha_1 - \alpha_2)^2}. \end{aligned} \quad (35)$$

In the second stage, the differentiation of π_i in Eq. (35) with respect to α_i yields the following optimal level of CSR of the firm:

$$\alpha_i = \frac{(1 - \tau)(7 + 5s_1 + 2s_2 - M)}{4 + 3s_1 + s_2}, \quad (36)$$

where $M = \sqrt{41 + 52s_1 + 16s_1^2 + 30s_2 + 20s_1s_2 + 5s_2^2}$ and $i = 1, 2$.

The resulting social welfare is

$$W = \frac{(21M - 125\tau + 25M\tau + 68s_1 - 14Ms_1 - 270\tau s_1 + 20M\tau s_1 - 6s_1^2 - 41 \\ - 70\tau s_1^2 - 110s_2 - 5Ms_2 + 20\tau s_2 + 5M\tau s_2 + 120s_1s_2 - 130\tau s_1s_2 - 115s_2^2 + 75\tau s_2^2)}{400}. \quad (37)$$

In the first stage, the government opts for discriminatory subsidies to maximize social welfare. As obtaining the explicit outcomes in the equilibrium is challenging, we use numerical simulations with $\tau \in (0, 1)$. Table 2 presents the equilibrium outcomes in this model, where superscript “*” represents the equilibrium outcome under the discriminatory subsidy. Note that $s_1^{B*} > 0$ and $s_2^{B*} \leq 0$ when $\tau \leq \tau_{B*} = 0.7842$. This implies that under discriminatory subsidies, a domestic firm can increase its competitive advantage when competing with a foreign-owned firm. However, the corporate tax rate directly affects the subsidy decision of the government regarding a foreign-owned firm. In particular, the government taxes the output of the foreign-owned firm when corporate tax is low, and subsidizes the output when corporate tax is high enough.

Table 2: Equilibrium outcomes in the bilateral CSR case under discriminatory subsidies.

τ	α^{B*}	s_1^{B*}	s_2^{B*}	π_1^{B*}	π_2^{B*}	W^{B*}
0	0.2162	0.3604	-0.2677	0.2471	0.0106	0.2933
0.1	0.1923	0.3550	-0.2511	0.2180	0.0114	0.2944
0.2	0.1687	0.3490	-0.2318	0.1894	0.0122	0.2958
0.3	0.1453	0.3422	-0.2091	0.1613	0.0130	0.2975
0.4	0.1222	0.3345	-0.1820	0.1340	0.0137	0.2996
0.5	0.0996	0.3255	-0.1491	0.1075	0.0142	0.3021
0.6	0.0774	0.3149	-0.1085	0.0820	0.0144	0.3053
0.7	0.0559	0.3019	-0.0571	0.0579	0.0141	0.3095
0.8	0.0355	0.2855	0.0101	0.0356	0.0127	0.3149
0.9	0.0166	0.2640	0.1017	0.0159	0.0089	0.3224
1	0	0.2339	0.2339	0	0	0.3333

Second, we consider a domestic CSR case. In the last stage, by substituting $\alpha_2 = 0$ into Eq. (35), we calculate the profit of the domestic firm. In the second stage, the differentiation of π_1 with respect to α_1 yields $\alpha_1 = \frac{(1-\tau)(2+3s_1-s_2)}{11+6s_1+5s_2}$. In the first stage, the differentiation of W with respect to s_i yields: $s_1^{D*} = \frac{2(4-3\tau)}{9(3-2\tau)}$ and $s_2^{D*} = \frac{3\tau-2}{3(3-2\tau)}$. Note that $s_1^{D*} > 0$ and $s_2^{D*} < 0$ when $\tau < \tau_{D*} = \frac{2}{3}$. The implication of discriminatory subsidies is similar to the bilateral CSR case. Then, the resulting optimal CSR is $\alpha_1^{D*} = \frac{(1-\tau)(4-3\tau)}{3(5-3\tau)}$. The profit of the firm is respectively $\pi_1^{D*} = \frac{7(4-3\tau)^2(1-\tau)}{54(3-2\tau)^2}$ and $\pi_2^{D*} = \frac{1-\tau}{6(3-2\tau)^2}$. Finally, the social welfare is $W^{D*} = \frac{5-3\tau}{6(3-2\tau)}$.

Third, we consider a foreign CSR case. In the last stage, by substituting $\alpha_1 = 0$ into Eq. (35), we obtain the profit of the foreign-owned firm. In the second stage, the differentiation of π_2 with respect to α_2 yields $\alpha_2 = \frac{(1-\tau)(2+3s_2-s_1)}{11+6s_2+5s_1}$. In the first stage, the differentiation of W with respect to s_i yields: $s_1^{F*} = \frac{10-7\tau}{23-14\tau}$ and $s_2^{F*} = \frac{7\tau-5}{23-14\tau}$. Note that $s_1^{F*} > 0$ and $s_2^{F*} < 0$ when $\tau < \tau_{F*} = \frac{5}{7}$. The implication of discriminatory subsidies is also similar to the bilateral CSR case. The resulting optimal CSR is $\alpha_2^{F*} = \frac{1-\tau}{13-7\tau}$. The profit of the firm is respectively $\pi_1^{F*} = \frac{3(10-7\tau)^2(1-\tau)}{2(23-14\tau)^2}$ and $\pi_2^{F*} = \frac{21(1-\tau)}{2(23-14\tau)^2}$. Finally, the social welfare is $W^{F*} = \frac{13-7\tau}{2(23-14\tau)}$.

Fourth, we consider a no CSR case. In the last stage, substituting $\alpha_1 = \alpha_2 = 0$, we confirm the social welfare. In the first stage, the differentiation of W with respect to s_i yields: $s_1^{N*} = \frac{4-3\tau}{3(3-2\tau)}$ and $s_2^{N*} = \frac{3\tau-2}{3(3-2\tau)} = s_2^{D*}$. Note that $s_1^{N*} > 0$ and $s_2^{N*} < 0$ when $\tau < \tau_{N*} = \frac{2}{3}$. The implication of discriminatory subsidies is still similar to the

bilateral CSR case. The profit of the firm is respectively $\pi_1^{N*} = \frac{(4-3\tau)^2(1-\tau)}{6(3-2\tau)^2}$ and $\pi_2^{N*} = \frac{1-\tau}{6(3-2\tau)^2} = \pi_2^{D*}$. Finally, the social welfare is $W^{N*} = \frac{5-3\tau}{6(3-2\tau)} = W^{D*}$.

Lastly, we compare the optimal levels of CSR, discriminatory subsidies, profits of the two firms, and social welfare among the four models. Figure 1 indicates the comparisons between the four models under discriminatory subsidies. Then, we obtain the following lemmas and propositions.

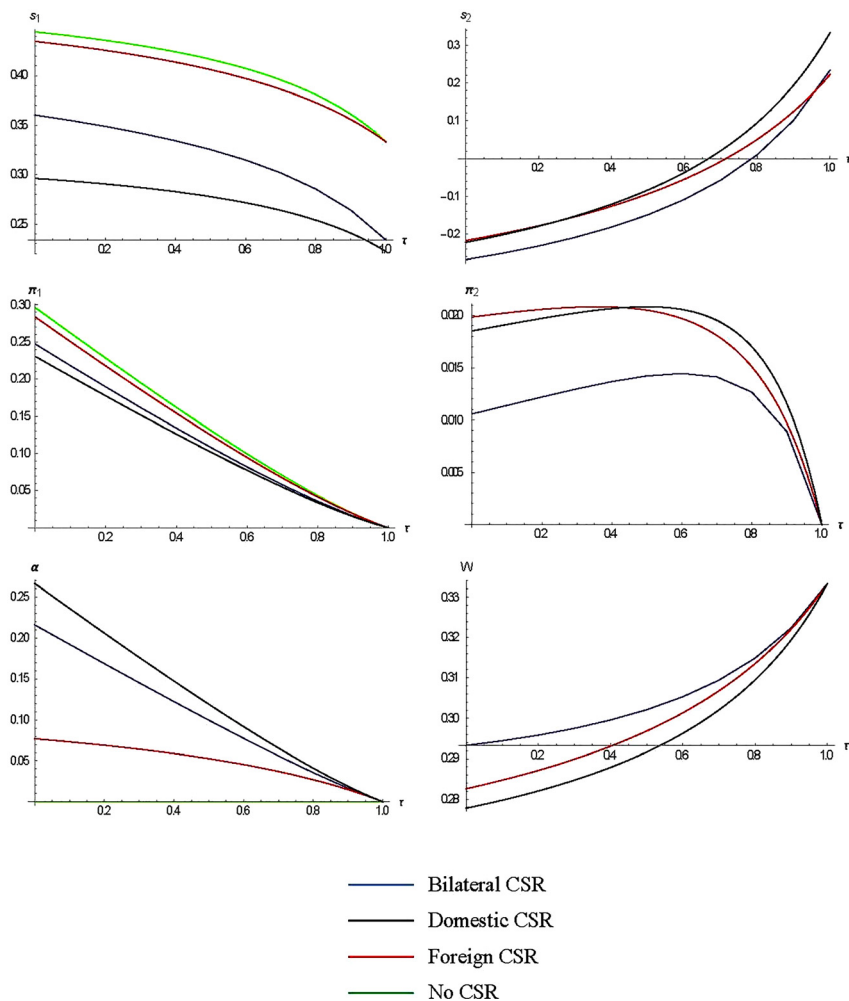


Figure 1: Comparisons among the four models under discriminatory subsidies.

Proposition 6: *The domestic CSR leads to the highest CSR level, while foreign CSR leads to the lowest CSR level under discriminatory subsidies.*

Proposition 6 implies that the discriminatory subsidy policy yields different levels of CSR in the two unilateral CSR cases, which is in contrast to the result under the uniform subsidy in Proposition 1, that is, $\alpha_1^{D*} > \alpha_i^{B*} > \alpha_2^{F*}$. While the government always grants (positive) an output subsidy to the domestic firm to increase the firm's competitive advantage under discriminatory subsidies, it will choose the highest CSR level only when the domestic firm engages in CSR activities. In contrast, the government taxes the output of the foreign-owned firm significantly to decrease the rent-leakage effect from the foreign-owned firm if $0 < \tau < \frac{5}{7}$. Thus, the foreign-owned firm will choose the lowest CSR level under foreign CSR.

Lemma 4: *The ranks of optimal discriminatory subsidies among the four models are as follows:*

- (i) $s_1^{N*} > s_1^{F*} > s_1^{B*} > s_1^{D*} > 0$;
- (ii) $0 > s_2^{F*} > s_2^{D*} = s_2^{N*} > s_2^{B*}$ when $0 < \tau < \frac{1}{4}$;
- (iii) $s_2^{D*} > s_2^{F*} = s_2^{N*} > s_2^{B*}$ when $\frac{1}{4} < \tau < 1$;
- (iii-1) $0 \geq s_2^{D*} > s_2^{F*} = s_2^{N*} > s_2^{B*}$ when $\frac{1}{4} < \tau \leq \tau_{D*}$;
- (iii-2) $s_2^{D*} > 0 \geq s_2^{F*} = s_2^{N*} > s_2^{B*}$ when $\tau_{D*} < \tau \leq \tau_{F*}$;
- (iii-3) $s_2^{D*} > s_2^{F*} = s_2^{N*} > 0 \geq s_2^{B*}$ when $\tau_{F*} < \tau \leq \tau_{B*}$;
- (iii-4) $s_2^{D*} > s_2^{F*} = s_2^{N*} > s_2^{B*} > 0$ when $\tau_{B*} < \tau < 1$.

Lemma 4 presents the policy relationships between optimal discriminatory subsidies and corporate tax rates. First, we illustrate that the optimal discriminatory subsidy of the domestic firm is independent of corporate tax. In particular, to enlarge market outputs, the government grants the highest subsidy to the domestic firm when none of the firms engage in CSR activities. As domestic CSR leads to the highest CSR level, the government grants the lowest subsidy to the domestic firm under domestic CSR.

Regarding the foreign-owned firm, we summarize the findings of Lemma 4 as follows: (a) $\min\{s_2^{D*}, s_2^{F*}, s_2^{N*}\} > s_2^{B*}$, and (b) $s_2^{F*} \leq s_2^{D*}$ when $\tau \leq \frac{1}{4}$. First, (a) the

optimal discriminatory subsidy of the foreign-owned firm under either unilateral CSR or no CSR is always higher than that under bilateral CSR. In order to decrease the over-production effect of CSR activities, the government will grant the lowest subsidy (or tax) to the foreign-owned firm when both firms engage in CSR activities, depending on the corporate tax rate. Second, (b) the optimal subsidy of the foreign-owned firm under foreign CSR is higher than under domestic CSR when corporate tax is low, while the opposite is found when corporate tax is high. Note that $0 > s_2^{F*} > s_2^{D*}$ when $0 < \tau < \frac{1}{4}$. Thus, when corporate tax is low enough, the government imposes a lower tax on the foreign-owned firm under foreign CSR than under domestic CSR. However, when corporate tax is high, the opposite is found, i.e., $s_2^{D*} > s_2^{F*} > 0$ when $\tau_{F*} < \tau < 1$. That is, the government imposes a lower subsidy on the foreign-owned firm under foreign CSR compared to domestic CSR.

Lemma 5: *The ranks of profits and social welfare under discriminatory subsidies are as follows:*

- (i) $\pi_1^{N*} > \pi_1^{F*} > \pi_1^{B*} > \pi_1^{D*}$;
- (ii) $\pi_2^{F*} \leq \pi_2^{D*} = \pi_2^{N*} > \pi_2^{B*}$ when $\tau \leq 1 - \frac{3\sqrt{7}}{14}$;
- (iii) $W^{B*} > W^{F*} > W^{D*} = W^{N*}$.

Lemma 5 states that the domestic firm is most profitable under no CSR, while it is the least profitable under domestic CSR in contrast to the result under the uniform subsidy in Lemma 3. Further, the foreign-owned firm generates minimum profit under bilateral CSR and maximum profit under foreign CSR (domestic CSR) when corporate tax is low (high). Lemma 5 also implies that irrespective of government policies that include discriminatory subsidies and corporate tax, bilateral CSR yields the highest social welfare, whereas no CSR yields the lowest social welfare. Note that $W^{F*} > W^{D*}$, which contrasts with the result under the uniform subsidy in Lemma 2. Under discriminatory subsidies, the government can impose a higher output tax on the foreign firm, as per Lemma 4, and thus increase government revenue. As a result, foreign CSR leads to higher social welfare than domestic CSR under the discriminatory subsidy.

Finally, we consider an endogenous choice game of CSR under discriminatory subsidies in which each firm decides whether to engage in CSR activities simultaneously and non-cooperatively before the first stage of the previous analysis.

Proposition 7: *Foreign CSR (no CSR) is a Nash equilibrium when corporate tax is low (high) under the discriminatory subsidy, while neither one is socially desirable.*

Proposition 7 illustrates that foreign CSR is a Nash equilibrium when τ is low, that is, $0 < \tau < 1 - \frac{3\sqrt{7}}{14}$, while no CSR is a Nash equilibrium when τ is high, for instance, $1 - \frac{3\sqrt{7}}{14} < \tau < 1$. Moreover, both foreign CSR and no CSR are the Nash equilibria when $\tau = 1 - \frac{3\sqrt{7}}{14}$. Note that this result contrasts with the result under the uniform subsidy in Proposition 5. However, Lemma 5 reveals that neither one of the Nash equilibria under the discriminatory subsidy is socially desirable.

6 Concluding Remarks

In this study, we examined strategic CSR in a Cournot duopoly between domestic and foreign-owned firms in a managerial delegation framework facing the government's public policies. We then investigated how the government could combine policies to regulate the firms' CSR behavior and to enhance market performance. Our main findings are as follows: first, the strategic effect of corporate profit tax on strategic CSR and the output subsidy policy, exists. In particular, the effects of corporate tax on strategic CSR and social welfare are conflicting: the strategic level of CSR decreases but social welfare increases with corporate tax. These results are robust under the discriminatory subsidy. This finding is significant for policymakers because corporate profit taxes are not neutral toward firm behavior in the presence of strategic CSR. Second, the optimal unilateral CSR is higher than bilateral CSR under the uniform subsidy, while domestic (foreign) CSR leads to the highest (lowest) CSR level under the discriminatory subsidy. However, irrespective of corporate tax or foreign penetration, social welfare is highest under bilateral CSR. Finally, the Nash equilibrium of an endogenous CSR choice game depends on corporate tax and output subsidy policies. In particular, when corporate tax is low, domestic CSR is a Nash equilibrium under the uniform subsidy, while foreign CSR is a Nash equilibrium under the discriminatory subsidy. However, neither is socially desirable. Therefore, an appropriate policy framework on CSR guidelines is necessary for lower corporate taxes.

Even though our methodology can be applied to different models with other public policies on CSR, future research avenues remain. For example, while we

regarded a corporate tax as an exogenously given parameter in this model, the government may determine it endogenously in the general equilibrium model. Alternative scenarios should include product differentiation, Stackelberg competition, and more general specifications for the demand and cost functions among the oligopolistic firms. Extending our analysis to different CSR activities with commitment investment would be another direction for future research.

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Appendix Proofs of Lemmas

Proof of Lemma 1: Comparing the value of τ_i provides: $\tau_1 < \tau_N < \tau_D < \tau_3 < \tau_B < \tau_F < \tau_2 < \tau_4 < \tau_5 < \tau_6$. Then, we have the following relationships:

- (i) $s^D - s^B = \frac{1204 - 182\sqrt{41} - 3(333 - 52\sqrt{41})\beta(1-\tau)}{(182 + 75\beta - 75\beta\tau)(6 + (\sqrt{41} - 4)\beta(1-\tau))} > 0$;
- (ii) $s^D - s^F = \frac{297\beta(1-\tau)}{2(13 + 6\beta - 6\beta\tau)(182 + 75\beta - 75\beta\tau)} > 0$;
- (iii) $s^N - s^B = \frac{(7 - \sqrt{41})(6 - 5\beta(1-\tau))}{3(2 + \beta - \beta\tau)(6 + (\sqrt{41} - 4)\beta(1-\tau))} > 0$;
- (iv) $s^N - s^F = \frac{10 - 3\beta + 3\beta\tau}{6(2 + \beta - \beta\tau)(13 + 6\beta - 6\beta\tau)} > 0$;
- (v) $s^D - s^N = \frac{-70 + 93\beta - 93\beta\tau}{3(2 + \beta - \beta\tau)(182 + 75\beta - 75\beta\tau)} \begin{matrix} < 0 & \text{when } \tau > \tau_1 = 1 - \frac{70}{93\beta} \\ > 0 & \text{when } \tau < \tau_1 = 1 - \frac{70}{93\beta} \end{matrix}$;
- (vi) $s^B - s^F = \frac{26\sqrt{41} - 172 + 3(48 - 7\sqrt{41})\beta(1-\tau)}{2(13 + 6\beta - 6\beta\tau)(6 + (\sqrt{41} - 4)\beta(1-\tau))} \begin{matrix} < 0 & \text{when } \tau < \tau_2 = 1 - \frac{2(397 - 22\sqrt{41})}{885\beta} \\ > 0 & \text{when } \tau > \tau_2 = 1 - \frac{2(397 - 22\sqrt{41})}{885\beta} \end{matrix}$.

Proof of Lemma 2: Comparing the social welfare among the four models provides the following relationships:

- (i) $W^B - W^D = \frac{2 + (784 - 121\sqrt{41})\beta(1-\tau)}{2(182 + 75\beta - 75\beta\tau)(6 + (\sqrt{41} - 4)\beta(1-\tau))} > 0$;
- (ii) $W^D - W^F = \frac{1089\beta(1-\tau)}{28(13 + 6\beta - 6\beta\tau)(182 + 75\beta - 75\beta\tau)} > 0$;
- (iii) $W^B - W^N = \frac{2(7 - \sqrt{41})\beta(1-\tau)}{3(2 + \beta - \beta\tau)(6 + (\sqrt{41} - 4)\beta(1-\tau))} > 0$;
- (iv) $W^N - W^F = \frac{2 - 27\beta + 27\beta\tau}{84(2 + \beta - \beta\tau)(13 + 6\beta - 6\beta\tau)} \begin{matrix} < 0 & \text{when } \tau < \tau_5 = 1 - \frac{2}{27\beta} \\ > 0 & \text{when } \tau > \tau_5 = 1 - \frac{2}{27\beta} \end{matrix}$;
- (v) $W^N - W^D = \frac{2 - 63\beta + 63\beta\tau}{6(2 + \beta - \beta\tau)(182 + 75\beta - 75\beta\tau)} \begin{matrix} < 0 & \text{when } \tau < \tau_6 = 1 - \frac{2}{63\beta} \\ > 0 & \text{when } \tau > \tau_6 = 1 - \frac{2}{63\beta} \end{matrix}$.

Proof of Lemma 3: First, comparing the profits of domestic firm provides the followings:

- (i) $\pi_1^D - \pi_1^B = \frac{(2(28(7999-1183\sqrt{41})+3192(\sqrt{41}-4)\beta(1-\tau)+3(55779-8651\sqrt{41})\beta^2(1-\tau)^2)(1-\tau))}{(182+75\beta-75\beta\tau)^2(6+(\sqrt{41}-4)\beta(1-\tau))^2} > 0;$
- (ii) $\pi_1^D - \pi_1^F = \frac{1089(33124+57876\beta(1-\tau)+18981\beta^2(1-\tau)^2)(1-\tau)}{392(182+75\beta-75\beta\tau)^2(13+6\beta-6\beta\tau)^2} > 0;$
- (iii) $\pi_1^N - \pi_1^B = \frac{2(12(7-\sqrt{41})+(69-11\sqrt{41})\beta^2(1-\tau)^2)(1-\tau)}{3(2+\beta-\beta\tau)^2(6+(\sqrt{41}-4)\beta(1-\tau))^2} > 0;$
- (iv) $\pi_1^N - \pi_1^F = \frac{(23596+13404\beta(1-\tau)+999\beta^2(1-\tau)^2)(1-\tau)}{1176(13+6\beta-6\beta\tau)^2(2+\beta-\beta\tau)^2} > 0;$
- (v) $\pi_1^N - \pi_1^D = \frac{4(1316-1596\beta(1-\tau)-999\beta^2(1-\tau)^2)(1-\tau)}{3(182+75\beta-75\beta\tau)^2(2+\beta-\beta\tau)^2} \leq 0 \text{ when } \tau \leq \tau_3 = 1 - \frac{176\sqrt{7}-266}{333\beta};$
- (vi) $\pi_1^B - \pi_1^F = \frac{(-856684+132496\sqrt{41}+13404(\sqrt{41}-4)\beta(1-\tau)+3(33608\sqrt{41}-210057)\beta^2(1-\tau)^2)(1-\tau)}{392(13+6\beta-6\beta\tau)^2(6+(\sqrt{41}-4)\beta(1-\tau))^2} \leq 0$
when $\tau \leq \tau_4 = 1 - \frac{2(13404-3351\sqrt{41}+3850(3(953\sqrt{41}-6100)^{1/2}))}{3\beta(33608\sqrt{41}-210057)}.$

Second, comparing the profits of foreign-owned firm provides the following:

- (i) $\pi_2^N - \pi_2^F = \frac{(376+12\beta(1-\tau)-81\beta^2(1-\tau)^2)(1-\tau)}{42(13+6\beta-6\beta\tau)^2(2+\beta-\beta\tau)^2} > 0;$
- (ii) $\pi_2^F - \pi_2^D = \frac{1089(1183-225\beta^2(1-\tau)^2)(1-\tau)}{14(182+75\beta-75\beta\tau)^2(13+6\beta-6\beta\tau)^2} > 0;$
- (iii) $\pi_2^D - \pi_2^B = \frac{(856684-132496\sqrt{41}-300(\sqrt{41}-4)\beta(1-\tau)-75(1268\sqrt{41}-8097)\beta^2(1-\tau)^2)(1-\tau)}{2(182+75\beta-75\beta\tau)^2(6+(\sqrt{41}-4)\beta(1-\tau))^2} > 0.$

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