Corporate Philanthropy and the Market Structure

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[Abstract]

This paper studies monopoly and duopoly firms' incentives to provide philanthropy — activity that is costly for firms but is beneficial to consumers. There are two goods that are related to each other. The goods are either provided by a monopolist or by two competing firms.

It is shown that when the goods are substitutes (complements), the equilibrium quantity, philanthropy level, consumer surplus, and social welfare are higher (lower) in duopoly than in monopoly market.

When the goods are independent, all the equilibrium values, including philanthropy level and social welfare, are the same between the duopoly and monopoly markets.

Keywords: Corporate philanthropy; market structure; substitutes and complements

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1.1 Introduction

This paper studies monopoly and duopoly firms' incentives to provide philanthropy. Corporate philanthropy refers to an activity that is costly for firms but is beneficial to consumers, such as donating money and products, supporting educational institutions and artistic activities, as well as providing public goods in place of local governments. The type of philanthropic activity that is considered in this paper is firms' recycling activity. Either private companies or local governments may bear the costs of recycling used goods and containers. The private provision of recycling reduces the community's burden, and makes consumers and the local government better off. What kind of market structure is conducive to the private provision of recycling? We compare monopoly and duopoly firms' incentives to supply philanthropy, i.e., to bear the cost of recycling. The market outcomes are then compared to the social optimum.

1.2 Comparison to the literature

Previous studies of corporate philanthropy have analyzed, among others, (i) why a profit-maximizing firm would provide corporate social responsibility; (ii) the determinants, including tax systems, of corporate philanthropic activity; (iii) the effect of corporate philanthropy on firm performance; and (iv) the relationship between corporate philanthropy, advertising intensity, and market competition.

The first strand of the literature includes Glazer and Konrad (1996), who offer a signaling explanation for charity. Porter and Kramer (2002) note that corporate philanthropy, such as strategic giving, can often be the most cost-effective way for a company to improve its competitive context; using philanthropy to enhance social context brings social and economic goals into alignment and improves the company's long-term business prospects. Bénabou and Tirole (2010) examine three views on CSR: First, CSR takes a long-term perspective to maximize intertemporal profits; second, stakeholders have demand for corporations to engage in philanthropy on their behalf; and third, CSR reflects management's own desires to engage in philanthropy. And Mao et al. (2015) offers rationale for a private company to provide both a private good and a philanthropic good when there are economies of scope between shared inputs.

As for the second type of the literature, Yamauchi (1997) examines the behavior of non-profit organizations and individual donors, and discusses the effects of tax deduction on donors. Shiozawa (2013) analyzes optimal expenditures on corporate

philanthropic activities and investment as well as dividend-payout ratios, and studies how preferential tax measures affect these activities. Masulis and Reza (2015), who examine agency problems of corporate philanthropy, find that corporate giving is positively associated with CEO charity preferences and negatively associated with CEO shareholdings and corporate governance quality. They argue that corporate donations advance CEO interests and suggest misuses of corporate resources that reduce firm value.

The third strand of the literature includes Seifert et al. (2004), who find that monetary donations do not affect firm financial performance. Bénabou and Tirole (2010) also state that empirical studies have looked at the relationship between CSR and stock returns/profits, but overall find a slightly positive or no correlation. On the other hand, Chen and Jiang (2015), who study a sample of listed Chinese companies, find a positive association between corporate philanthropy and access to bank loans.

Perhaps the literature that is most related to this paper is the one that has examined the relationship between corporate philanthropy, advertising, and competition. Using data on Chinese firms' response to the 2008 Sichuan earthquake, Zhang et al. (2010) shows empirically that corporate donation is positively associated with firm advertising intensity and industry competition. Fisman et al. (2006) also report preliminary empirical finding that corporate philanthropy and profits are positively related only in industries with high advertising intensity and high competition.

The focus of this paper is to *theoretically* analyze the effect of the market structure on corporate philanthropy; i.e., whether or not a monopolist provides more philanthropic activities than duopoly, and which market structure is socially more beneficial. In this paper, there are two goods that are related to each other. The two goods are either provided by a monopolist or by two competing firms.

We find that when the two goods are substitutes (complements), the equilibrium quantity, philanthropy level, consumer surplus, and social welfare are higher (lower) in the duopoly market than in the monopoly market.

And when the two goods are independent, the equilibrium prices, quantities, philanthropic activity levels, profits, consumer surplus, and social welfare are the same between the duopoly and monopoly markets. In all three cases, philanthropy levels and social welfare in the private markets are lower than in the first-best.

These results are caused by the fact that compared to the duopoly, the monopolist

takes into account the effect of one good's price/quantity on the other good; when the two goods are independent, this effect is absent, so the equilibrium values are the same between the monopoly and the duopoly markets. When the two goods are complements, the monopolist chooses lower prices (larger quantities) and higher level of philanthropy than the duopoly firms, in order to stimulate the demand for both goods. And the opposite result holds when the two goods are substitutes.

The theoretical results of this paper are consistent with the empirical findings of Zhang et al. (2010) for the case in which the goods are substitutes. In addition, we also analyze the cases in which the goods are complements and independent.

2. The Model

2.1 The basic setup

Consider a market with two goods, 1 and 2, and a number of consumers. There is also a numeraire good 0 that is supplied in a competitive market; its price p_0 is normalized at 1. The other two goods are supplied by either a monopolist or by two firms. In the monopoly market, a single firm supplies both products at prices p_1^M and p_2^M (throughout the paper, superscripts denote the market structure, and subscripts denote the goods), and provides a_1^M and a_2^M levels of 'philanthropy' associated with each good. 'Philanthropy' in this paper refers to corporate activity that is costly to firms but offers benefits for consumers. For example, the firm(s) might provide eco-friendly recycle system that would otherwise have to be provided by the local government. In the duopoly market, the prices and the levels of philanthropy are determined by two competing firms. Denote the monopoly market by superscript M and the duopoly market by D.

A representative consumer consumes goods 0, 1, 2, and also derives utility from corporate philanthropy, to be specified in the next subsection.

2.2 Consumers

There are N identical consumers. A representative consumer buys x_0 units of numeraire good 0 at price 1, and x_1^s and x_2^s units of products 1 and 2 (where market structure $s = M, D$). Let Y be his income, which is exogenously given. The consumer's budget constraint is

$$x_0^s + p_1^s x_1^s + p_2^s x_2^s = Y.$$

A representative consumer has the utility function that leads to a linear demand curve:

$$U(x_0^s, x_1^s, x_2^s) = x_0^s + (\alpha + a_1^s)x_1^s + (\alpha + a_2^s)x_2^s - \tfrac{1}{2}[(x_1^s)^2 + 2\gamma x_1^s x_2^s + (x_2^s)^2],$$

where α is a positive constant, a_i^s (i = 1, 2) is the level of corporate philanthropy provided by firm i in market s ($s = M, D$), and γ measures the degree of substitutability between goods 1 and 2. Goods 1 and 2 are substitutes (independent, complements, respectively) if γ is positive (zero, negative). The values of parameters α and γ are known to everyone. For demand, prices, and corporate philanthropic activities to be nonnegative, assume that the range of γ is restricted to the following interval:

[A.1] $-0.5 < \gamma < 0.75$.

It is shown in the following subsections that all the equilibrium values will be positive if γ satisfies assumption [A.1]. It is also shown in the Appendix that utility and profits are indeed maximized if γ lies in the range specified in [A.1].

Substituting the budget constraint into the utility function, a consumer maximizes

$$(1) \quad \underset{x_1^s,\, x_2^s}{\text{Max}}\ U(x_1^s, x_2^s) = (Y - p_1^s x_1^s - p_2^s x_2^s) + \sum_{i=1}^{2}(\alpha + a_i^s)x_i - \tfrac{1}{2}[(x_1^s)^2 + 2\gamma x_1^s x_2^s + (x_2^s)^2].$$

The first-order conditions satisfy

$$(2) \quad \partial U/\partial x_i^s = -p_i^s + (\alpha + a_i^s) - x_i^s - \gamma x_j^s = 0 \quad (i, j = 1, 2).$$

Solving (2), an individual's demand for product i (i, j = 1, 2) in market s is given by

$$(3) \quad x_i^s = \{(1 - \gamma)\alpha + (a_i^s - \gamma a_j^s) - p_i^s + \gamma p_j^s\}/(1 - \gamma^2).$$

Since $\partial^2 U/\partial (x_i^s)^2 = -1$, $\partial^2 U/\partial x_i^s \partial x_j^s = -\gamma$, and $|\gamma| < 1$, the demand functions (3) are indeed obtained by maximizing consumer's utility.

To the extent that the demand for good i rises with a_i^s, philanthropic activity is similar to advertising; Friedman (1983) analyzes a dynamic oligopolistic market in which advertising enhances goodwill and leads to increased sales (see also Martin, 1993). Empirical studies such as Brammer and Millington (2005) and Zhang et al. (2010) do find positive association between firm advertising intensity and corporate giving. Advertising will not be considered in this paper however, because consumers are fully informed, so corporate philanthropy is likely to be more effective than advertising in enhancing consumer goodwill.

For ease of notation, assume that N, the number of consumers, equals 1. The market demand is equal to the representative consumer demand (3). It can be shown that all the analyses of this paper will continue to hold for the case $N > 1$.

2.3 Duopoly market

Suppose that goods 1 and 2 are provided by two independent firms. For simplicity, we assume that both firms have a unit production cost of c and incur no fixed costs, and that the cost of providing corporate philanthropy is quadratic in the level of activity, as given in equation (4) below. It is assumed that c is small relative to α, so that

[A.2] $\alpha - c > 0$.

In duopoly market, firm i sets the price and the level of corporate philanthropic activity to

(4) $\underset{p_i^D,\, a_i^D}{\text{Max}}\ \Pi_i^D = (p_i^D - c)x_i^D - (a_i^D)^2$
$= (p_i^D - c)\{(1-\gamma)\alpha + (a_i^D - \gamma a_j^D) - p_i^D + \gamma p_j^D\}/(1-\gamma^2) - (a_i^D)^2 \quad (i, j = 1, 2).$

The first-order conditions for each firm are

(5) $\partial\Pi_i^D/\partial p_i^D = \{(1-\gamma)\alpha + (a_i^D - \gamma a_j^D) - 2p_i^D + \gamma p_j^D + c\}/(1-\gamma^2) = 0$, and

(6) $\partial\Pi_i^D/\partial a_i^D = \{(p_i^D - c)/(1-\gamma^2)\} - 2a_i^D = 0$.

From (5) and (6), the second-order conditions for profit maximization are satisfied in the duopoly market, given assumption [A.1]:

$$\begin{bmatrix} \partial^2\Pi_i^D/(\partial p_i^D)^2 & \partial^2\Pi_i^D/\partial p_i^D\partial a_i^D \\ \partial^2\Pi_i^D/\partial p_i^D\partial a_i^D & \partial^2\Pi_i^D/(\partial a_i^D)^2 \end{bmatrix} = \begin{bmatrix} -2 & 1 \\ 1 & -2(1-\gamma^2) \end{bmatrix}/(1-\gamma^2).$$

Note that $4(1-\gamma^2) - 1 = 3 - 4\gamma^2 > 0$, given [A.1].

Eq. (6) shows that the level of philanthropy is proportional to the price-cost margin:

(7) $a_i^D = (p_i^D - c)/2(1-\gamma^2)$.

Substituting (7) into (5) and reorganizing, the reaction functions in prices are

(8) $p_i^D = \{2(1-\gamma)(1-\gamma^2)\alpha + (1-\gamma)(1+2\gamma)c + \gamma(1-2\gamma^2)p_j^D\}/(3-4\gamma^2)$.

In (8), $1 + 2\gamma > 0$, $1 - 2\gamma^2 > 0$, and $3 - 4\gamma^2 > 0$, given [A.1], so the reaction functions are upward-sloping if $\gamma > 0$, and downward-sloping if $\gamma < 0$; following Bulow et al. (1985), the two goods are *strategic complements* if $\gamma > 0$, and *strategic substitutes* if $\gamma < 0$.

Solving (8), the equilibrium prices in the duopoly market are

(9) $p_1^D = p_2^D = \{2(1-\gamma^2)\alpha + (1+2\gamma)c\}/(3 + 2\gamma - 2\gamma^2)$. //

The price-cost margin for each firm is

(10) $p_i^D - c = 2(1-\gamma^2)(\alpha - c)/(3 + 2\gamma - 2\gamma^2)$.

Substituting (10) into (7), the equilibrium corporate philanthropy levels in the duopoly market are

(11) $a_1^D = a_2^D = (\alpha - c)/(3 + 2\gamma - 2\gamma^2)$. //

Substituting (9) and (11) into (3), the equilibrium quantities in the duopoly market are

(12) $x_1^D = x_2^D = (\alpha + a_i^D - p_i^D)/(1 + \gamma)$
$= 2(\alpha - c)/(3 + 2\gamma - 2\gamma^2)$. //

As shown in (11) and (12), the level of corporate philanthropy (firms' recycling activity) is proportional to the quantity sold.

And the firms' profits in the duopoly market are

(13) $\Pi_i^D = (p_i^D - c)\, x_i^D - (a_i^D)^2 = (3 - 4\gamma^2)(\alpha - c)^2/(3 + 2\gamma - 2\gamma^2)^2 \quad (i = 1, 2)$. //

Because the equilibrium prices, quantities, philanthropic activities, and the profits are the same for the two firms, we will drop subscripts 1, 2 in the following analyses.

The representative consumer purchases the following units of the numeraire good:

(14) $x_0^D = Y - 2p^D x^D$
$= Y - [\{4(1 - \gamma^2)\alpha + 2(1 + 2\gamma)c\}/(3 + 2\gamma - 2\gamma^2)] \times [2(\alpha - c)/(3 + 2\gamma - 2\gamma^2)]$.

And his utility level in the duopoly market is obtained by substituting (12) and (14) into (1):

(15) $U^D(x_0^D, x_1^D, x_2^D) = Y - 2p^D x^D + 2(\alpha + a^D)x^D - (1 + \gamma)(x^D)^2$
$= Y + 4(1 + \gamma)(\alpha - c)^2/(3 + 2\gamma - 2\gamma^2)^2$. //

Since we've assumed that $N = 1$, (15) is equal to the utility level of all consumers.

Assume Y is sufficiently large so that x_0^D is nonnegative. Assumptions [A.1] and [A.2] ensure that all the values in (9) ~ (15) are positive.

2.4 Monopoly market

The basic setup is the same as in the duopoly market, except that the monopolist chooses prices and the levels of philanthropic activities in order to maximize *the joint profit* from the two goods:

(16) $\underset{p_i^M,\, a_i^M}{\text{Max}}\, \Pi^M = (p_1^M - c)x_1^M - (a_1^M)^2 + (p_2^M - c)x_2^M - (a_2^M)^2$
$= \sum_{i=1}^{2}[(p_i^M - c)\{(1-\gamma)\alpha + (a_i^M - \gamma a_j^M) - p_i^M + \gamma p_j^M\}/(1-\gamma^2) - (a_i^M)^2] \quad (i,j=1,2)$.

The first-order conditions for the monopolist are

(17) $\partial\Pi^M/\partial p_i^M = \{(1 - \gamma)\alpha + (a_i^M - \gamma a_j^M) - 2p_i^M + \gamma p_j^M + c + \gamma(p_j^M - c)\}/(1 - \gamma^2) = 0$, and

(18) $\partial\Pi^M/\partial a_i^M = \{(p_i^M - c)/(1 - \gamma^2)\} - \gamma\{(p_j^M - c)/(1 - \gamma^2)\} - 2a_i^M = 0$.

Compared to the first-order conditions in the duopoly market (5) and (6), the monopolist takes into account the effects of price i and philanthropic activity associated with good i on the other good j. If the two goods are independent ($\gamma = 0$), this effect is zero, so the monopolist and duopoly firms will choose the same levels of prices and philanthropic activities. If the two goods are substitutes ($\gamma > 0$), a higher price in one

market leads to higher demand for the other good, so the monopolist can afford to set higher prices in both markets than the duopoly firms. On the other hand, if the two goods are complements ($\gamma < 0$), the monopolist sets lower prices than the duopoly firms in order to stimulate demand for both goods.

It is shown in the Appendix that the second-order conditions for maximization are satisfied in the monopoly market as well.

From (18), the level of philanthropic activity is given by:

(19) $a_i^M = \{(p_i^M - c) - \gamma(p_j^M - c)\}/2(1 - \gamma^2)$.

Substituting (19) into (17) and reorganizing, the monopolist's choice of the prices satisfies

(20) $p_i^M = \{2(1 - \gamma)(1 - \gamma^2)\alpha + (1 - \gamma)(1 + \gamma - 2\gamma^2)c + 2\gamma(1 - 2\gamma^2)p_j^M\}/(3 - 5\gamma^2)$.

Solving (20), the equilibrium prices in the monopoly market are given by

(21) $p_1^M = p_2^M = \{2(1 + \gamma)\alpha + (1 + 2\gamma)c\}/(3 + 4\gamma)$. //

The price-cost margin for the monopolist is

(22) $p_i^M - c = 2(1 + \gamma)(\alpha - c)/(3 + 4\gamma)$.

Substituting (22) into (19), the equilibrium corporate philanthropy levels in the monopoly market are

(23) $a_1^M = a_2^M = (\alpha - c)/(3 + 4\gamma)$. //

Substituting (22) and (23) into (3), the equilibrium quantities in the monopoly market are

(24) $x_1^M = x_2^M = (\alpha + a_i^M - p_i^M)/(1 + \gamma)$

$= 2(\alpha - c)/(3 + 4\gamma)$. //

And the monopolist's profit is

(25) $\Pi^M = \sum_{i=1}^{2}[(p_i^M - c)x_i^M - (a_i^M)^2] = 2(\alpha - c)^2/(3 + 4\gamma)$. //

Because the monopolist chooses the same prices, quantities, and the philanthropic activity levels for the two goods, subscripts 1, 2 will be dropped in the following analyses.

The representative consumer purchases the following units of the numeraire good:

(26) $x_0^M = Y - 2p^M x^M = Y - [\{4(1 + \gamma)\alpha + 2(1 + 2\gamma)c\}/(3 + 4\gamma)] \times 2[(\alpha - c)/(3 + 4\gamma)]$.

And his utility level in the monopoly market is obtained by substituting (24) and (26) into (1):

(27) $U^M(x_0^M, x_1^M, x_2^M) = Y - 2p^M x^M + 2(\alpha + a^M)x^M - (1 + \gamma)(x^M)^2$

$= Y + 4(1 + \gamma)(\alpha - c)^2/(3 + 4\gamma)^2$. //

Assumptions [A.1] and [A.2] ensure that all the values in (21) ~ (27) are positive.

2.5 The first best

Suppose that a social planner, rather than the firms, chooses the prices and the levels of philanthropic activities. Denote this 'first-best' case by an asterisk. The planner would set the prices equal to the unit cost of production ($p_1^* = p_2^* = c$), and let the consumers bear the cost of philanthropic activities. The level of philanthropic activities would be chosen so as to

(28) $\underset{x_i^*,\, a_i^*}{\text{Max}}\, U(x_i^*, a_i^*) = Y + \sum_{i=1}^{2}[(\alpha+a_i^*)x_i^* - cx_i^* - (a_i^*)^2] - \frac{1}{2}[(x_1^*)^2 + 2\gamma x_1^* x_2^* + (x_2^*)^2]$.

The first-order conditions are

(29) $\partial U^*/\partial x_i^* = (\alpha + a_i^*) - c - (x_i^* + \gamma x_j^*) = 0$, and

(30) $\partial U^*/\partial a_i^* = x_i^* - 2a_i^* = 0$.

It is shown in the Appendix that the second-order conditions for utility maximization are satisfied in the first-best case as well.

From (30), the philanthropic activity level in the first-best case satisfies

(31) $a_i^* = (x_i^*)/2$.

Substituting (31) into (29) and solving for x_i^*, the equilibrium quantities in the first-best case are

(32) $x_1^* = x_2^* = 2(\alpha - c)/(1 + 2\gamma)$. //

The equilibrium levels of philanthropic activity in the first-best case are

(33) $a_1^* = a_2^* = (\alpha - c)/(1 + 2\gamma)$. //

The firm profit is zero in the first-best case. And consumer utility is given by

(34) $U^*(x_0^*, x_1^*, x_2^*) = Y - 2cx^* - 2(a^*)^2 + 2(\alpha + a^*)x^* - (1 + \gamma)(x^*)^2$

$= Y + 2(\alpha - c)^2/(1 + 2\gamma)$. //

Assumptions [A.1] and [A.2] ensure that all the values in (32) ~ (34) are positive.

3. Comparisons

Let's now compare the equilibrium values in duopoly, monopoly, and the first-best cases. The equilibrium quantities are

(12) $x_1^D = x_2^D \equiv x^D = 2(\alpha - c)/(3 + 2\gamma - 2\gamma^2)$ in the duopoly market,

(24) $x_1^M = x_2^M \equiv x^M = 2(\alpha - c)/(3 + 4\gamma)$ in the monopoly market, and

(32) $x_1^* = x_2^* \equiv x^* = 2(\alpha - c)/(1 + 2\gamma)$ in the first-best case.

The duopoly and monopoly outputs are strictly less than the first best; because $(3 + 2\gamma - 2\gamma^2) - (1 + 2\gamma) = 2(1 - \gamma^2) > 0$, we can see that

(35) $x^* > x^D$. //

Likewise, $(3 + 4\gamma) - (1 + 2\gamma) = 2(1 + \gamma) > 0$, so

(36) $x^* > x^M$. //

And $(3+4\gamma) - (3+2\gamma - 2\gamma^2) = 2\gamma(1 - \gamma)$. The sign of the RHS is the same as the sign of γ, so

(37) $x^D \geq x^M$ as $\gamma \geq 0$; $x^D < x^M$ as $\gamma < 0$. //

Next, the levels of philanthropic activities are

(11) $a_1^D = a_2^D \equiv a^D = (\alpha - c)/(3 + 2\gamma - 2\gamma^2)$ in the duopoly market,

(23) $a_1^M = a_2^M \equiv a^M = (\alpha - c)/(3 + 4\gamma)$ in the monopoly market, and

(33) $a_1^* = a_2^* \equiv a^* = (\alpha - c)/(1 + 2\gamma)$ in the first-best case.

We can readily see that the level of philanthropy is highest in the first-best case:

(38) $a^* > a^D$,

(39) $a^* > a^M$, and

(40) $a^D \geq a^M$ as $\gamma \geq 0$; $a^D < a^M$ as $\gamma < 0$. //

Third, the prices are

(9) $p_1^D = p_2^D \equiv p^D = \{2(1 - \gamma^2)\alpha + (1 + 2\gamma)c\}/(3 + 2\gamma - 2\gamma^2)$ in the duopoly market,

(21) $p_1^M = p_2^M \equiv p^M = \{2(1 + \gamma)\alpha + (1 + 2\gamma)c\}/(3 + 4\gamma)$ in the monopoly market, and

(41) $p_1^* = p_2^* \equiv p^* = c$ in the first-best case.

Simple calculations show that the first-best price is the lowest:

(42) $p^D - p^* = 2(1 - \gamma^2)(\alpha - c)/(3 + 2\gamma - 2\gamma^2) > 0$. //

(43) $p^M - p^* = 2(1 + \gamma)(\alpha - c)/(3 + 4\gamma) > 0$. //

Whether the monopoly price is higher than the duopoly price depends on the sign of γ.

(44) $p^M - p^D = 2\gamma(1 + \gamma)(1 + 2\gamma)(\alpha - c)/\{(3 + 4\gamma)(3 + 2\gamma - 2\gamma^2)\}$.

Assumptions [A.1] and [A.2] ensure that $(1+\gamma)(1+2\gamma)(\alpha - c)/\{(3+4\gamma)(3+2\gamma - 2\gamma^2)\} > 0$, so

(45) $p^M \geq p^D$ as $\gamma \geq 0$; $p^M < p^D$ as $\gamma < 0$. //

Namely, when goods 1 and 2 are substitutes ($\gamma > 0$), the prices are strategic complements in the duopoly market. In this case, the monopoly price is higher and the quantity is smaller than in the duopoly market, just as in the standard case. And the level of corporate philanthropy is smaller in the monopoly than in the duopoly market.

On the other hand, when the two goods are complements ($\gamma < 0$), the prices are strategic substitutes in the duopoly market. In this case, the monopoly price is *lower*, and the quantity and the philanthropic activity level are *higher* in the monopoly than in

the duopoly market.

The outcomes in the monopoly and duopoly markets are caused by the fact that the monopolist sets prices and philanthropic activity levels in order to maximize *the joint profit* from both goods. The monopolist thus takes into account the effects of the price and philanthropic activity of one good on the other good as well.

If the two goods are independent ($\gamma = 0$), the reaction functions in prices are independent of each other in the duopoly market. In this case, the monopolist and the duopoly firms choose the same levels of prices, quantities, and philanthropic activities, because the choices of these variables have no impact on the other good.

For all values of γ, the monopoly and duopoly prices are higher than the first-best level. Accordingly, the monopoly and duopoly quantities and the levels of corporate philanthropy are smaller than in the first-best case.

Fourth, the firms' profits are

(13) $\Pi^D = (3 - 4\gamma^2)(\alpha - c)^2/(3 + 2\gamma - 2\gamma^2)^2$ in the duopoly market, and

(25) $\Pi^M = 2(\alpha - c)^2/(3 + 4\gamma)$ in the monopoly market.

The firm profit is zero in the first-best case.

The monopoly profit is greater than twice the duopoly profits for all nonzero values of γ:

(46) $\Pi^M/2\Pi^D = (3 + 2\gamma - 2\gamma^2)^2/\{(3 + 4\gamma)(3 - 4\gamma^2)\}$

$= (9 + 12\gamma - 8\gamma^2 - 8\gamma^3 + 4\gamma^4)/(9 + 12\gamma - 12\gamma^2 - 16\gamma^3)$

$> 1.$

The last inequality in (46) follows because the numerator – the denominator = $4\gamma^2(1 + \gamma)^2 > 0$ for all nonzero values of γ. The monopoly profit equals twice the duopoly profits if the two goods are independent.

Fifth, consumer's utility levels are

(15) $U^D(x_0^D, x^D) = Y + \{4(1 + \gamma)(\alpha - c)^2\}/(3 + 2\gamma - 2\gamma^2)^2$ in the duopoly market,

(27) $U^M(x_0^M, x^M) = Y + \{4(1 + \gamma)(\alpha - c)^2\}/(3 + 4\gamma)^2$ in the monopoly market, and

(34) $U^*(x_0^*, x^*) = Y + \{2(\alpha - c)^2\}/(1 + 2\gamma)$ in the first-best.

Not surprisingly, consumer utility in the first-best case is higher than in the monopoly or duopoly markets:

(47) $U^* - U^D = 2(\alpha - c)^2[(3 + 2\gamma - 2\gamma^2)^2 - 2(1 + \gamma)(1 + 2\gamma)]/\{(1 + 2\gamma)(3 + 2\gamma - 2\gamma^2)^2\}$

$= 2(\alpha - c)^2[7 + 6\gamma - 12\gamma^2 - 8\gamma^3 + 4\gamma^4]/\{(1 + 2\gamma)(3 + 2\gamma - 2\gamma^2)^2\}$

$> 0.$ //

The inequality in (47) holds because $[7+6\gamma -12\gamma^2 -8\gamma^3 +4\gamma^4] = 6-8\gamma^2 +(6\gamma -8\gamma^3)+(1- 4\gamma^2 +4\gamma^4) = 2(1+\gamma)(3-4\gamma^2) + (1-2\gamma^2)^2 > 0$, given [A.1]. And all other factors are positive.

(48) $U^* - U^M = 2(\alpha - c)^2[(3 + 4\gamma)^2 - 2(1 +\gamma)(1 + 2\gamma)]/\{(1 + 2\gamma)(3 + 4\gamma)^2\}$
$= 2(\alpha - c)^2[7 + 18\gamma + 12\gamma^2]/\{(1 + 2\gamma)(3 + 4\gamma)^2\}$
$> 0.$ //

The inequality in (48) holds because $7+18\gamma +12\gamma^2 > 7 - (18/2) + (12/4) > 0$, given [A.1].

On the other hand, the relative sizes of consumer utilities in the monopoly and duopoly markets depend on the sign of γ:

(49) $U^D - U^M = 4(1 +\gamma)(\alpha - c)^2[(3 + 4\gamma)^2 - (3 + 2\gamma - 2\gamma^2)^2]/\{(3 + 2\gamma - 2\gamma^2)^2(3 + 4\gamma)^2\}$
$= 16\gamma(1 +\gamma)(\alpha - c)^2[3 + 6\gamma + 2\gamma^2 - \gamma^3]/\{(3 + 2\gamma - 2\gamma^2)^2(3 + 4\gamma)^2\}.$

Now $[3 + 6\gamma + 2\gamma^2 - \gamma^3] = 3(1 + 2\gamma) + \gamma^2(2- \gamma) > 0$, given [A.1]. Thus

(50) $U^D \geq U^M$ as $\gamma \geq 0$; $U^D < U^M$ as $\gamma < 0$. //

When the two goods are substitutes ($\gamma > 0$), the quantity and the philanthropic activities are larger and the price is lower in the duopoly market as compared to the monopoly market. Consumers are better off in the duopoly market. The converse holds for the case in which the two goods are complements ($\gamma > 0$). And when the goods are independent ($\gamma = 0$), consumers are indifferent between the duopoly and monopoly markets.

Finally, social welfare can be compared. Social welfare in this paper is simply the sum of consumer surplus and firm profits:

(51) $W^D = U^D + 2\Pi^D = Y + \{2(\alpha - c)^2(5 + 2\gamma - 4\gamma^2)\}/(3 + 2\gamma - 2\gamma^2)^2$ in duopoly,

(52) $W^M = U^M + \Pi^M = Y + \{2(\alpha - c)^2(5 + 6\gamma)\}/(3 + 4\gamma)^2$ in monopoly, and

(34) $W^* = U^* = Y + \{2(\alpha - c)^2\}/(1 + 2\gamma)$ in the first-best.

Not surprisingly, social welfare is strictly highest in the first-best case:

(53) $(W^* - Y)/(W^D - Y) = (3 + 2\gamma - 2\gamma^2)^2/\{(1 + 2\gamma)(5 + 2\gamma - 4\gamma^2)\}$
$= (9 + 12\gamma - 8\gamma^2 - 8\gamma^3 + 4\gamma^4)/(5 + 12\gamma - 8\gamma^3)$
$> 1.$ //

The last inequality in (53) holds because the numerator – denominator $= 4(1 - \gamma^2)^2 > 0$.

(54) $(W^* - Y)/(W^M - Y) = (3 + 4\gamma)^2/\{(1 + 2\gamma)(5 + 6\gamma)\}$
$= (9 + 24\gamma + 16\gamma^2)/(5 + 16\gamma + 12\gamma^2)$
$> 1.$ //

The last inequality in (54) holds because the numerator – denominator $= 4(1 + \gamma)^2 > 0$.

As for the relative sizes of W^D and W^M, we know from (46) and (50) that for $\gamma < 0$,

the profits and consumer utility levels are both lower in the duopoly market than in the monopoly market ($2\Pi^D < \Pi^M$ and $U^D < U^M$). Thus when the two goods are complements, social welfare is *lower* in the duopoly market ($W^D < W^M$ for $\gamma < 0$). When the two goods are independent, social welfare is the same in both markets ($W^D = W^M$ for $\gamma = 0$).

On the other hand, calculation shows that $W^D > W^M$ for $\gamma > 0$:

(55) $(W^D - Y)/(W^M - Y) = \{(5 + 2\gamma - 4\gamma^2)(3 + 4\gamma)^2\}/\{(5 + 6\gamma)(3 + 2\gamma - 2\gamma^2)^2\}$

$= (45+138\gamma +92\gamma^2 -64\gamma^3-64\gamma^4)/(45+114\gamma +32\gamma^2 -88\gamma^3-28\gamma^4 +24\gamma^5)$

> 1 when $\gamma > 0$. //

The inequality in (55) holds because the numerator – denominator = $12\gamma\{2(1+\gamma)+\gamma(1-\gamma^2)(3+2\gamma)\} > 0$ for $\gamma > 0$.

Summarizing the above, we have

Proposition: The equilibrium values in the three cases are such that

(a) For $\gamma > 0$, $p^* < p^D < p^M$; $x^M < x^D < x^*$; $a^M < a^D < a^*$;
$2\Pi^D < \Pi^M$; $U^M < U^D < U^*$; and $W^M < W^D < U^*$;

(b) For $\gamma = 0$, $p^* < p^D = p^M$; $x^D = x^M < x^*$; $a^D = a^M < a^*$;
$2\Pi^D = \Pi^M$; $U^D = U^M < U^*$; and $W^D = W^M < U^*$; and

(c) For $\gamma < 0$, $p^* < p^M < p^D$; $x^D < x^M < x^*$; $a^D < a^M < a^*$;
$2\Pi^D < \Pi^M$; $U^D < U^M < U^*$; and $W^D < W^M < U^*$. //

4. Conclusion

This paper analyzed monopoly and duopoly firms' incentives to provide corporate philanthropy — activity that is costly for firms but is beneficial to consumers. There are two goods that are related with each other. The two goods are provided either by a monopolist or by two firms. The market equilibrium outcomes are also compared to the first-best case.

When the two goods are substitutes, prices are strategic complements. In this case, we found that the equilibrium quantities and philanthropy levels are lower in the monopoly market than in the duopoly market, and the monopoly prices are higher than the duopoly prices. While the monopoly profit is higher than twice the duopoly profits, consumer utility and social welfare are higher in duopoly than in monopoly.

On the other hand, when the two goods are complements, the prices are strategic substitutes. In this case, the equilibrium quantities and philanthropy levels are *higher* in the monopoly market, and the monopoly prices are *lower* than the duopoly prices. Both

firm profits and consumer utility level are *higher* in the monopoly market, thus social welfare is *higher* in monopoly than in duopoly.

And when the two goods are independent, the prices are strategically independent of each other. In this case, the equilibrium prices, quantities, philanthropic activity levels, profits, consumer surplus, and social welfare are the same between the duopoly and monopoly markets.

In all three cases, philanthropy levels and social welfare in both the monopoly and duopoly markets are socially suboptimal.

That a monopolist earns a higher profit than the sum of duopoly profits is not surprising. In addition, when the two goods are complements, the monopoly outcome is closer to the first-best than the duopoly market outcome. This is due to the fact that a monopolist makes a more integrated decision than two separate firms, just as vertical integration resolves the problem of double markup in a vertical model with a manufacturer and a distributor (Carlton and Perloff, 2005).

The results of this paper imply that corporate philanthropic activities depend on the market structure and the way the goods are interrelated with each other. When the goods are competing against each other (substitutes), the competitive duopolistic market leads to higher levels of philanthropy and social welfare than the monopoly market; and when the goods complement each other, the centralized monopolist provides higher levels of philanthropy and social welfare than in the duopoly market. It would be interesting to generalize the analysis to a multiple goods case in which some goods are substitutes and others are complements to each other.

[Appendix] The second-order conditions

[A.a] Monopoly

The monopolist chooses $p_1^M = p_2^M \equiv p^M$, and $a_1^M = a_2^M \equiv a^M$.

The first-order conditions are

$$(17)\quad \partial \Pi^M/\partial p^M = \{(1-\gamma)\alpha + (1-\gamma)a^M - 2(1-\gamma)p^M + (1-\gamma)c\}/(1-\gamma^2)$$
$$= \{\alpha + a^M - 2p^M + c\}/(1+\gamma) = 0, \text{ and}$$
$$(18)\quad \partial \Pi^M/\partial a^M = \{(1-\gamma)(p^M - c)/(1-\gamma^2)\} - 2a^M$$
$$= \{p^M - c - 2(1+\gamma)a^M\}/(1+\gamma) = 0.$$

The second-order total differential is

(A1) $(1+\gamma)d^2\Pi^M = [dP^M \;\; da^M] \begin{bmatrix} -2 & 1 \\ 1 & -2(1+\gamma) \end{bmatrix} \begin{bmatrix} dP^M \\ da^M \end{bmatrix} \equiv \boldsymbol{y'Dy}.$

Note that $|D_1| = -2$, and $|D_2| = 4(1+\gamma) - 1 = 3 - 4\gamma > 0$ from assumption [A.1]; it follows that $d^2\Pi^M$ is negative definite. //

[A.b] First-best

The social planner chooses $x_1^* = x_2^* \equiv x^*$, and $a_1^* = a_2^* \equiv a^*$.

The first-order conditions are

(29) $\partial U^*/\partial x^* = (\alpha + a^*) - c - (1+\gamma)x^* = 0$, and

(30) $\partial U^*/\partial a^* = x^* - 2a^* = 0$.

The second-order total differential is

(A2) $d^2U^* = [dx^* \;\; da^*] \begin{bmatrix} -(1+\gamma) & 1 \\ 1 & -2 \end{bmatrix} \begin{bmatrix} dx^* \\ da^* \end{bmatrix} \equiv \boldsymbol{z'D^*z}.$

Because $|D^*_1| = -(1+\gamma) < 0$, and $|D^*_2| = 2(1+\gamma) - 1 = 1 + 2\gamma > 0$ from assumption [A.1], it follows that d^2U^* is also negative definite. //

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