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By-product Lobbying with Rival Public Goods

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Abstract

A by-product firm uses the profits from the sale of a private good to finance provision of a public good. In this paper, I allow for the possibility that the public good provided by the by-product firm exhibits rivalry. If the public good exhibits any degree of rivalry, then an increase in group size will lead to a reduction in the provision of the public good, assuming that the number of by-product firms is held constant. An increase in the number of by-product firms raises provision of the public good, if the group size is held constant. When the group size and the number of by-product firms are increased in the same proportion, the effect on provision of the public good depends upon the degree of rivalry exhibited by the public good.

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1. Introduction

In *The Logic of Collective Action*, Mancur Olson argues that large groups are frequently unable to provide themselves with public goods. One mechanism which may overcome the free-rider problem inherent in public good provision is by-product lobbying. A by-product firm sells a private good to consumers and uses the profits to provide a public good which those consumers value. Consider the example of the American Association of Retired Persons (AARP). Members of the AARP pay dues and receive private goods such as a magazine and group discounts. The AARP is then able to use its profits to lobby the government on such issues as social security and Medicare. Closely related to by-product lobbying is the idea of corporate social responsibility (Baron 2001 and Besley and Ghatak 2007). A specific example of corporate social responsibility is green goods (Kotchen, 2006) under which the profits from the sale of a private good are used to purchase environmental amenities which are a public good.

George Stigler (1974: 360) criticized the by-product theory by arguing that competition from other firms would eliminate monopoly rents and leave the by-product firm unable to lobby. Pecorino (2001) showed that by-product lobbying firms could survive the free entry of for-profit firms in a monopolistically competitive market structure. In particular, the by-product firm is able to provide a higher level of the public good than would be obtained through direct contributions in a single shot game. Importantly, in this model the by-product firm uses its profits to finance provision of a pure public good.

By-product lobbying is explicitly posited as a way in which large groups can overcome the free-rider problem. One reason why the free-rider problem is worse in large groups is that the stakes per person tend to be small (Olson 1965: 46-52), which implies that most public goods exhibit a positive degree of rivalry. Thus, in this paper I consider by-product lobbying where the

public good provided by the by-product firm may exhibit a degree of rivalry. Suppose that the public good exhibits a small degree of rivalry, but that the number of by-product lobbying firms is held constant. I show that as group size grows large, the level of provision of the public good will approach zero in this case. However, if the group size is held constant, while the number of by-product lobbying firms is allowed to increase, the level of provision of the public good will increase. If the group size and the number of by-product firms are allowed to grow in the same proportion, there is an ambiguous effect on provision of the public good. When the degree of rivalry and the production function for the public good are both described by power functions, the level of provision of the public good is increasing in group size if the rivalry parameter is less than one half the output elasticity parameter for the public good. Conversely, when the rivalry parameter is more than one half the output elasticity parameter, provision of the public good is decreasing in group size. By-product lobbying can succeed in a large group provided that the degree of rivalry of the public good is not too high.

The framework in this paper is similar to that provided in Pecorino (2001), but there are some important differences. Pecorino (2001) is a partial equilibrium analysis of monopolistic competition, while the analysis here is a general equilibrium analysis based on the Krugman (1980) model. In Pecorino (2001) there is a pure public good which provides the benefit $G(S)$, where G is a concave function of contributions S . In this paper, the per person benefit from the public good is $G(S)/L^\psi$, where $0 \leq \psi \leq 1$ and the population size is denoted by L . If $\psi = 0$, we have a pure public good and if $\psi = 1$, the good is fully rival. For intermediate values of ψ , the good in question exhibits some degree of rivalry, but is less than fully rival. In addition, in Pecorino (2001), the number of by-product firms is fixed (at one), while here I consider the effect on public good provision of an increase in the number of by-product firms.

2. Related Works

Posnett and Sandler (1986) show that a charity in a perfectly competitive goods market can charge a premium for a private good which reflects the private valuation of charitable activity, a public good. In a perfectly competitive framework, a by-product lobbying firm can generally only replicate the outcome associated with private contributions in a single shot noncooperative game. The by-product lobbying mechanism in Pecorino (2001) bears a resemblance to Morgan's (2000) lottery mechanism. In Pecorino (2001), consumers have an increased willingness to pay for a private good because they know that the profit on that good is used to finance a public good which they value. Similarly in Morgan, consumers are willing to pay more for a lottery ticket, because they know that profits on the sale are used to finance a public good.¹

In the papers cited above there is no technological advantage (e.g., economies of scope) to having a firm provide both a private good and a public good. There are also no warm glow effects enjoyed by consumers who buy from a by-product firm. Thus the analysis here is distinct from the related literature on impure public goods in which the technology of production (or preferences, i.e., the warm glow effect) leads a public good and a private good to be jointly supplied.² However, there is a literature on by-product lobbying which incorporates these assumptions. For example, Bagnoli and Watts (2003) analyze by-product lobbying assuming that consumers receive a warm glow benefit by making a purchase from a socially responsible firm. They analyze a variety of market structures and while public goods are frequently underprovided, there are some situations in which they are provided at an inefficiently high level. By contrast, Kotchen (2006) analyzes green goods while allowing a technological advantage for

¹ Another related work is Engers and McManus (2007) who analyze charity auctions.

firms which jointly provide the private good and public good. The market for private goods is perfectly competitive. In contrast with Bagnoli and Watts, Kotchen also allows for direct contributions to the public good as an alternative to the joint purchase of the public and private good. Among other results, he finds an ambiguous welfare effect arising from the presence of by-product firms relative to a situation where only direct private contributions to the public good are available.

Besley and Ghatak (2007) analyze corporate social responsibility in a setting with heterogeneous consumers and perfectly competitive firms.³ A socially responsible firm contributes towards production of a public good, which some of the consumers value. Under perfect competition, the socially responsible firms are able to replicate the outcome that would occur if consumers made direct contributions toward provision of the public good. Besley and Ghatak then consider the existence of transaction costs and characterize conditions under which the private sector, via corporate social responsibility, would have a comparative over both the government and direct charitable contributions in providing public goods.⁴

While Kotchen (2006) and Besley and Ghatak (2007) analyze different issues than are addressed in this paper, it is important not to let terminology obscure the similarities across the papers. I am using the term “by-product lobbying” to link the paper back to Olson (1965) and to Stigler’s critique of Olson. However, in all three papers (and in Pecorino 2001, as well), firms provide public goods with profits earned on the sale of private goods. Thus, the public good

² For an overview of the literature which addresses these issues, see the work of Sandler (1992) and Cornes and Sandler (1996). Also see Andreoni (1989, 1990).

³ Baron (2001) also addresses the issue of corporate social responsibility.

⁴ In contrast to the papers above, Mayer (2002) takes the monopoly position of the by-product firm as given and analyzes the behavior of this firm. When price discrimination is not possible, the by-product firm faces a trade-off between two distortions. If it prices at marginal cost, the firm can efficiently provide private inputs to members of the industry association, but it cannot lobby. If it charges a price above marginal cost, it will have funds with which to lobby, but there is an inefficient provision of the private input. When price discrimination is possible, this problem is alleviated.

provided in my paper can be interpreted as a green good, and the act of providing it can be interpreted as an act of corporate social responsibility.

In his chapter on by-product lobbying, Olson (1965) gives several examples of the phenomenon. He cites professional organizations such as the American Medical Association and the American Bar Association, as well as labor unions and farm organizations. In each case, these organizations provide private benefits to their members (via journals, technical information, etc.) and are able to lobby the government with profits they earn from the dues payments they receive. More recently, there has been an empirical analysis of the related phenomenon of green goods. Teisl, Row and Hicks (2002) find that demand for tuna increased in response to dolphin safe labeling, where the safety of dolphins provides a public good to some consumers. Casadesus-Masanell et al. (2009) show that consumers are willing to pay more for clothing made with organic cotton. They argue that organic cotton provides no direct consumption benefit over cotton which is not organically grown, so that the willingness to pay must be related to the environmental benefits provided by the organic farming methods. These articles indicate that it is plausible to model consumers as having an increased willingness to pay when a public good is linked to the purchase of a private good.

3. The Model

In the model which follows, there is a monopolistically competitive market structure for the private good, where a subset of firms in the industry lobbies with their profits to provide a public good. The model of monopolistic competition is based on Krugman (1980). In section 3.1, I will present the model with by-product lobbying and for comparison purposes, the model with direct

contributions only will be presented in section 3.2. The optimal level of provision will be analyzed in section 3.3.

3.1. By-product Lobbying

Consumers are identical and indexed by $j = 1, \dots, L$. Consumption of good i , by consumer j is denoted C_{ij} , where goods are indexed by $i = 1, \dots, n$. Consumer preferences reflect a love of variety for goods produced within the industry class and are given by

$$U_j = \sum_{i=1}^n C_{ij}^\theta, \quad (1)$$

where $0 < \theta < 1$. The firms producing the varieties indexed $i = 1 \dots m$ are produced by by-product firms. The number of varieties n available to consumers is determined endogenously, but the number of by-product firms $m < n$ is treated as exogenous.

I assume that the public good in question is an intermediate input into production which enhances individual productivity.⁵ In particular, increases in the level of the public good increase an individual's effective labor supply above 1. The public good can be thought of as infrastructure, where this infrastructure may be subject to crowding. Thus, the per person benefit of the infrastructure may be decreasing in the total number of workers, L . The total population size is also assumed to equal L . The benefits of the public good are nonexcludable.

Let $G(L_I)$ be the output of the infrastructure, where L_I is labor devoted to producing the public good. I assume that $G' > 0$, $G'' < 0$, $G'(L_I)$ is finite for $L_I > 0$ and for L_I sufficiently large, $G'(L_I) < 1$. This last condition ensures that at an interior equilibrium, there will be a finite level

⁵ For a discussion of public goods as intermediate inputs into production, see Sandler (1992: 136-43). If the public good in this model was a consumption good, this would provide a separate avenue through which an increase in group size could reduce public good provision. The reason is that in this model, an increase in group size leads to an increase in the number of private goods available for consumption and therefore an increase in the marginal utility of consumption. This in turn would reduce the premium consumers would willingly pay to a by-product firm. This mechanism is addressed in a model with a direct contributions in Pecorino (2009). (By-product lobbying is not

of provision of the public good. The provision of the public good is potentially degraded by crowding effects. Let the level of provision of the public good be given by

$$g = \frac{G(L_I)}{L^\psi}, \quad (2)$$

where, ψ is a coefficient which determines the magnitude of the crowding effect arising from increases in L . When $\psi = 0$, the infrastructure is a pure public good as there is no crowding.

When $\psi = 1$, the good is fully rival.

The effective labor supply of individual j is

$$L_{Ej} = 1 + g, \quad (3)$$

All consumers earn the wage w , and all earnings are from wages. Due to a zero profit condition which is imposed on for-profit firms, the consumer does not receive any dividends.

The budget constraint for consumer j is

$$w(1 + g) - \sum_{i=1}^n P_i C_{ij} = 0, \quad (4)$$

where P_i is the price of commodity i .

Each firm produces a single variety of the good which is unique. The production technology is identical across goods and is given by

$$\begin{aligned} l_i &= \alpha + \beta X_i, \text{ for } X_i > 0 \text{ and} \\ l_i &= 0, \text{ for } X_i = 0, \end{aligned} \quad (5)$$

addressed in this paper.) The distinction between an intermediate and consumption good would not be important in a partial equilibrium setting, where the marginal utility of consumption is constant.

where X_i is output by firm i , l_i is labor employed by firm i , α is a fixed labor input and β is the marginal labor input required to produce one more unit of the good. The parameter α leads to a fixed but avoidable cost, as this cost is not incurred if output is 0. The production technology in (5) leads to increasing returns to scale.

Each firm takes the wage rate w as given. The technology in (5) leads to a fixed cost of αw and a constant marginal cost of βw . The goods $i = 1, \dots, m$ are produced by by-product firms, and the goods $i = m+1, \dots, n$, are produced by conventional for-profit firms. The by-product firms contribute their profits towards the provision of the public good. These profits are used to hire labor at the wage w to produce the public good, where $L_I = (1/w) \sum_{i=1}^m \Pi_i$ and $\sum_{i=1}^m \Pi_i$ denotes the sum of the profits earned by the by-product firms.. Thus we can express output of the public

good as $G\left(\sum_{i=1}^m (\Pi_i / w)\right)$.

Consumers recognize that when they make a purchase from a by-product firm, that its profits will rise by the difference between price and marginal cost which equals $P_i - \beta w$. The by-product firm contributes this marginal profit towards provision of the public good and as a result, $P_i/w - \beta$ units of labor can be hired to produce the public good. This increases the consumer's

effective labor supply by $(P_i/w - \beta) G'\left(\sum_{i=1}^m (\Pi_i / w)\right) / L^{\psi}$ units and increases the consumer's

income by $(P_i - w\beta) G'\left(\sum_{i=1}^m (\Pi_i / w)\right) / L^{\psi}$. This benefit of the public good effectively reduces the

price of a good produced by the by-product firm to $P_i - [P_i - \beta w] G'\left(\sum_{i=1}^m (\Pi_i / w)\right) / L^{\psi}$. Consumers

recognize this benefit when making a purchase from the by-product firm and this is reflected in equation (6) below.

Consumers act to maximize their utility in (1), subject to (2), (4) and the relationship between their purchase of commodities $i = 1, \dots, m$, and the supply of the public good. Equation (6) is derived from the first order condition with respect to goods produced by the by-product firms and equation (7) is derived with respect to goods produced by for-profit firms.

$$C_{ij} = \left[\frac{\lambda_j}{\theta} \left(P_i - [P_i - \beta w] G' \left(\sum_{i=1}^m (\Pi_i / w) \right) / L^\psi \right) \right]^{\frac{1}{\theta-1}}, \quad i = 1, \dots, m, \quad (6)$$

$$C_{ij} = \left(\frac{\lambda_j}{\theta} P_i \right)^{\frac{1}{\theta-1}}, \quad i = m+1, \dots, n. \quad (7)$$

Note that λ_j is a the lagrangian multiplier for person j and reflects the marginal utility of income.

If firms $i = 1, \dots, m$, were ordinary for-profit firms, the term in parentheses in (6) would simply be

$$P_i, \text{ but because these are by-product firms, we have the term } P_i - [P_i - \beta w] G' \left(\sum_{i=1}^m (\Pi_i / w) \right) / L^\psi .$$

Since all are identical, the values of consumption and of the lagrangian multiplier will be the same across consumers. Thus in what follows, I will write C_i to denote per person consumption of commodity i and λ to denote the common value of the marginal utility of income.

All firms have identical profit functions given by

$$\Pi_i = (P_i - \beta w) X_i - \alpha w. \quad (8)$$

Each firm chooses its own price to maximize profits while taking the prices of the other firms as given. Profit maximization is subject to the first order condition of the consumers given in (6) and (7). As in Krugman (1980), we assume that each firm takes λ , the marginal utility of income as given. The first order condition for each firm is

$$\frac{d\Pi_i}{dP_i} = X_i + (P_i - \beta w) \frac{dX_i}{dP_i} = 0, i = 1, \dots, n. \quad (9)$$

The zero profit condition, which applies for all the for-profit firms, may be expressed as

$$P_i X_i - \alpha w - \beta w X_i = 0, i = m+1, \dots, n. \quad (10)$$

Since the number of consumers is identical to the number of workers, we have

$$X_i = LC_i. \quad (11)$$

Using (6), (7), (9), (10) and (11), we can solve for price, consumption, and quantity produced for all goods:⁶

$$P_i = \frac{\beta w}{\theta} \left(\frac{L^\psi - \theta G' \left(\sum_{i=1}^m (\Pi_i / w) \right)}{L^\psi - G' \left(\sum_{i=1}^m (\Pi_i / w) \right)} \right), i = 1, \dots, m, \quad (12a)$$

$$P_i = \frac{\beta w}{\theta}, i = m+1, \dots, n, \quad (12b)$$

$$C_i = \frac{\alpha \theta}{L \beta (1 - \theta)}, i = 1, \dots, n, \quad (12c)$$

$$X_i = \frac{\alpha \theta}{\beta (1 - \theta)}, i = 1, \dots, n. \quad (12d)$$

The solutions in (12b-d) are the same as those we would obtain in a model without by-product lobbying. Note that output and consumption are the same as for goods produced by for-profit firms, while the price set by the by-product firms in (12a) exceeds the price set by the for profit firm in (12b).

Using equations (8), (12a) and (12d), and imposing symmetry, we can express profits for an individual by-product firm as

$$\Pi_B = \alpha w \left(\frac{G'(m\Pi_B/w)}{L^\psi - G'(m\Pi_B/w)} \right), \quad (13)$$

where Π_B is the level of profit earned by a representative by-product firm. Note that $L_I = m\Pi_B/w$. Since $\Pi_B > 0$, it exceeds the profit of the for profit firms, which equals 0. Will there be a positive level of profits such that (13) is satisfied? Suppose that $G'(0) < L^\psi$. The right-hand side of (13) is positive and the left-hand side is 0 at $\Pi_B = 0$. As we raise Π_B above 0, the right-hand side monotonically decreases, so there must be a unique positive value of Π_B such that the two sides are equal. Similarly, if $G'(0) > L^\psi$, the conditions on G guarantee that there is a finite value of Π_B such that $G' = L^\psi$. At this point, the left-hand side of (13) is finite and the right-hand side infinite. As Π_B increases above this value, the right-hand side will monotonically decrease implying the existence of a unique value of Π_B such that (13) holds. Thus, we have a unique positive value of Π_B that solves (13). In addition, when profits are maximized the following condition holds:

⁶ As per usual, we can only solve for relative prices. If both sides of (12a) and (12b) are divided by w , then we obtain the relative price of each good measured in units of labor.

$$G'(m\Pi_B^{Max}/w) < L^\psi. \quad (14)$$

This condition will prove useful in Section 4 when comparing the level of provision under by-product lobbying to that achieved under direct contributions. Since $L_I = m\Pi_B / w$, from (13) we have⁷

$$L_I = m\Pi_B / w = \alpha m \left(\frac{G'(L_I)}{L^\psi - G'(L_I)} \right). \quad (15)$$

Equation (15) provides the solution for labor devoted to production of the public good. This is one of the key equations which will be used to derive the main results of the paper.⁸

3.2. The Direct Contributions Mechanism

Next, for the purposes of comparison, I will present the result of the model without by-product lobbying firms, but where consumers may make direct contributions towards the public good.

With the apparatus derived in the previous subsection, we can easily examine what would happen if there were no by-product lobbying firms, but where consumers are able to make direct contributions to the public good. Assume that all n firms are standard for profit firms and that each individual may make a direct contribution $s_j \geq 0$ to the public good. The consumer's budget constraint is now

$$w(1 + g) = s_j + \sum_{i=1}^n P_i C_{ij}, \quad (16)$$

⁷ While it is not a central concern of this paper, it is worth noting from (15) that an increase in fixed costs (reflected by an increase in α) will raise the level of public good provision.

⁸ The labor market clearing condition and the solution for the number of firms do not play a role in the derivations which follow, but I will provide them here. Letting L_G be labor devoted to providing private goods and L_I be labor devoted to providing the public good, the labor market clearing condition is $L_G + L_I = L(1 + g)$, where the right hand side is effective labor supply. Substitute (15) into the labor market clearing condition to solve for L_G . It is also true that $L_G = \sum_{i=1}^n l_i$. Using (5) and (12d) we can solve for the number of firms: $n = (1 - \theta)L_G / \alpha$.

where $g = G(S/w)/L^\psi$ and $S = \sum_{j=1}^L s_j$. Firms have access to the same technology as before. It is straightforward to show that in this model, P_i , C_i , and X_i are given by equations (12b-d) for $i = 1, \dots, n$. If we assume an interior solution, then the first order condition with respect to provision of the public good may be expressed as

$$\frac{G'(S/w)}{L^\psi} = 1. \quad (17)$$

If $\psi > 0$, then we have $d(S/w)/dL = \psi L^{\psi-1} / G''(S/w) < 0$; direct contributions are monotonically decreasing in group size. If $G'(0) = \infty$, then as L grows large, (17) can only hold if S/w approaches 0. (Recall that $G'(S/w)$ is finite for $S/w > 0$). Alternatively, suppose that $G'(0)$ is finite. Then above some finite value of L there will be a corner solution with $S = 0$ (because above some finite L , we have $G'(0)/L^\psi < 1$). Thus if there is any degree of rivalry, the direct contributions mechanism always does worse as group size increases, and completely breaks down in a large group.

3.3. The Optimal Level of Provision

It is straightforward to show that an optimal provision of the public good leads to the condition⁹

$$\frac{L}{L^\psi} G'(L_I) = 1. \quad (18)$$

Recall that $g = G(L_I)/L^\psi$ and use (18) to obtain

⁹ Equation (18) may be obtained by optimizing social welfare with respect to the public good while taking the distortions associated with monopolistic competition as given. For-profit firms need to earn zero profits in equilibrium. Thus any attempt to improve social welfare via a reduction in price of privately provided goods would require some compensating subsidy to the firms. Such an intervention seems unrealistic. Thus, it is reasonable to optimize with respect to the public good, while taking the distortions from monopolistic competition as given.

$$\frac{dg^o}{dL} = \left[\frac{(\psi - 1)(G'(L_t^o)^2) - \psi G(L_t^o)G''(L_t^o)}{L^{\psi+1}G''(L_t^o)} \right], \quad (19)$$

where the ‘o’ is used to denote the optimal value of the variable. Since the numerator is of indeterminate sign, we cannot say in general whether, under an optimal level of provision, g is rising or falling in L . If $\psi = 0$ (a pure public good), $dg^o/dL > 0$. Conversely, if $\psi = 1$ (a fully rival good), $dg^o/dL < 0$. More generally, $dg^o/dL > 0$ if and only if $(\psi - 1)(G'(L_t^o)^2) < \psi G(L_t^o)G''(L_t^o)$.

For the purpose of later comparison, it will be useful to consider a parametric example. Consider an example, where $G(L_t) = L_t^\gamma$ and $0 < \gamma < 1$. Using (18), under the optimal level of provision we have

$$g^o = \gamma^{\frac{\gamma}{1-\gamma}} L^{\frac{\gamma-\psi}{1-\gamma}}. \quad (20)$$

If $\gamma > \psi > 0$, then g^o grows without bound as L increases. Thus, a failure to provide the public good would potentially lead to large welfare losses in this case. Conversely, if $\gamma < \psi$, g^o goes to 0 as group size becomes large. Thus, the individual consequences from a failure to provide the public good are not very significant when $\gamma < \psi$.

4. Results

In subsection 4.1, I will present a result concerning the relationship between the level of provision under by-product lobbying compared to the level of provision under the direct contributions mechanism. In subsection 4.2, I will present two results relating to the effect an increase in the group size L on public good provision. These results are derived holding the

number of by-product lobbying firms constant. In subsection 4.3, I consider the effect of increasing the number of by-product firms m while holding group size L constant. Finally, in subsection 4.4, I will consider the effect of equiproportionate increases in L and m . In section 4.5, I revisit Stigler's critique of Olson's by-product theory in light of the results of the model.

4.1. A Comparison of By-product Lobbying and the Direct Contributions Mechanism

For the first result, we will compare the level of provision under the by-product lobbying mechanism to the level of provision from the direct contributions mechanism. We know from equation (14) that under by-product lobbying $G'(m\Pi_B^{Max}/w)/L^\psi < 1$. By contrast, under direct contributions from (17) we have $G'(S/w)/L^\psi = 1$. This implies (due to the curvature properties of the G function) that there is a greater level of public good provision under by-product lobbying than under direct contributions. Thus, when direct contributions and by-product lobbying are both allowed, we will only observe by-product lobbying. The reason is that profit maximization by the by-product firm ensures that $G'(m\Pi_B^{Max}/w)/L^\psi < 1$. Under this condition, no individual will wish to make a direct contribution. This is summarized as Result 1:

Result 1: (i) The level of provision of the public good under by-product lobbying exceeds that achieved under direct contributions. (ii) When direct contributions and by-product lobbying are allowed simultaneously, no direct contributions will be made.

Result 1 generalizes a result in Pecorino (2001: 389) by allowing for a degree of rivalry in the provision of the public good. This result indicates that by-product lobbying is superior to direct contributions as a method for providing the public good.

Why does by-product lobbying provide a greater level of the public good than direct contributions? From Posnett and Sandler (1986), we know that a by-product firm in a perfectly

competitive market can replicate the outcome that occurs when there are direct contributions. Under perfect competition, price equals marginal cost for a for-profit firm. Under monopolistic competition, price exceeds marginal cost for for-profit firms. Consumers understand that for a by-product firm, the gap between price and marginal cost goes to provide a public good which they value. This increases their willingness to pay for the private good which in turn increases the gap between price and marginal cost. It is gap between price and marginal cost in the monopolistically competitive setting which allows the level of provision under by-product lobbying to exceed the level under direct contribution.

4.2. The Effects of an Increase in Group Size L .

Next, we will consider the comparative static effects of increasing the group size L , while holding the number of by-product firms m constant. From equation (15), we can derive the effect of an increase in population on the quantity of labor hired to provide the public good:

$$\frac{dL_I}{dL} = \frac{-\alpha m \psi L^{\psi-1} G'(L_I)}{(L^{\psi} - G'(L_I))^2 - \alpha m G''(L_I) L^{\psi}} \leq 0. \quad (21)$$

If $\psi = 0$, $dL_I / dL = 0$ so that the level of provision does not vary with the population size L . Thus for a pure public good, the level of provision does not vary with L .¹⁰ When $\psi > 0$, $dL_I / dL < 0$.

Since labor devoted to production of the public good falls, the provision of the public good $g = G(L_I)/L^{\psi}$ declines even more rapidly with L when $\psi > 0$. Also note that $dL_I / dL < 0$ implies that total profits earned by the by-product firms are falling in L . This is summarized as Result 2:

Result 2: If the number of by-product firms m is held constant and the public good exhibits any degree of rivalry ($\psi > 0$), total profits of the by-product firms $m\Pi_B$, labor

devoted to production of the public good L_I , and the provision of the public good g are all monotonically decreasing in group size L .

When the public good is rival, increases in group size reduce the premium consumers are willing to pay to the by-product firm, because the crowding effect reduces the benefit produced by their purchase. In addition, holding L_I constant, the crowding effect reduces g . For both these reasons, there are reductions in the provision of the public good as the group size increases.

We can also use (15) to obtain a limit result. First note that if $\psi = 0$, L_I does not vary with L so that the level of provision is both positive and constant in the limit as L grows large. If $\psi > 0$ then as the population grows large, L^ψ approaches ∞ . This implies that L_I approaches 0 as L approaches ∞ . To see why, suppose this were not true and that L_I takes on a finite positive value in the limit. Since $G'(L_I)$ is finite for $L_I > 0$ this implies that the denominator of (15) approaches ∞ as L approaches ∞ . Since the numerator is finite, this implies that L_I approaches 0 contradicting the assumption that $L_I > 0$. Thus, as L approaches ∞ , L_I approaches 0 which implies that total by-product firm profits $m\Pi_B/w$ approach 0 and that provision of the public good $g = G(L_I)/L^\psi$ approaches 0. This is summarized as Result 3:

Result 3: Under by-product lobbying with the number of by-product firms m held constant, if the public good exhibits any degree of rivalry ($\psi > 0$), labor devoted to production of the public good L_I , total by-product firm profits, $m\Pi_B/w$, and the provision of the public good $g = G(L_I)/L^\psi$ all approach 0 as group size L approaches ∞ .

¹⁰ This matches Result 4 in Pecorino (2001).

Result 3 is also driven by the effect of rivalry. As noted above, in the presence of rivalry an increase in L reduces the premium consumers are willing to pay to a by-product firm. In addition, any given level of contributions is degraded due to the crowding effect. While there are more consumers available to pay the premium in a larger group, this factor is never strong enough to overcome the negative effects of an increase in group size. Thus, provision is decreasing in group size and falls to 0 in a large group when there is any degree of rivalry, even if the good in question is close to being a pure public good (i.e., $\psi > 0$, but small). The analysis from section 3.3 indicates that in at least some cases, the failure to provide the public good in large groups will impose a significant cost on society. In particular, if ψ is positive, but not too large, the optimal level of provision g^o will rise without bound, while g falls to 0 in a large group.

Results 2 and 3 indicate that by-product lobbying cannot overcome the fundamental problem of providing public goods in a large group when $\psi > 0$, and the number of by-product firms m is held constant. If the public good is pure ($\psi = 0$), then by-product lobbying can succeed in a large group. In this case, the per person level of provision is constant as the group size grows.

4.3. The Effect of an Increase in the Number of By-product Lobbying Firms

The analysis in subsection 4.2 considers the effect of increases in group size L , while holding the number of by-product firms m constant. In this section, I consider increases in m , while holding L constant.

In order to see the effect of an increase in the number of by-product firms, use equation (15) to take the derivative of L_I with respect to m :

$$\frac{dL_I}{dm} = \frac{\alpha G'(L_I)(L^\psi - G'(L_I))}{(L^\psi - G'(L_I))^2 - \alpha m L^\psi G''(L_I)} > 0. \quad (22)$$

From equation (14), $G'(L_I) < L^\psi$. (Recall that $L_I = m\Pi_B^{Max} / w$.) This ensures the positive sign of dL_I/dm . If L_I increases, this implies that the total profits of the by-product firms increase.

Furthermore, since L is held constant, an increase in L_I implies an increase in provision of the public good, $g = G(L_I)/L^\psi$. This is summarized as Result 4:

Result 4: When the number of by-product firms m increases, holding group size L constant, labor devoted to production of the public good L_I , total profits earned by the by-product firms $m\Pi_B$, and the level of provision of the public good g all rise.

It is worth noting that from (13), we can show that the profits of an individual by-product firm falls with an increase in m , but what is important for public good provision is that total profits $m\Pi_B$ rise. Why does an increase in m raise total profits of the by-product firms? As discussed earlier, the reason that by-product lobbying is able to achieve a higher level of provision than under direct contributions relates to the gap between price and marginal cost which exists under monopolistic competition. When one more firm becomes a by-product firm, this creates an additional product with a gap between price and marginal cost and this in turn leads to an increase in funds which can be raised for the public good.

For example, suppose that there is only one by-product firm and that the market is initially in equilibrium. Now a second firm decides to convert from being for profit to being a by-product firm. Suppose initially that the profits of the first firm stay at their original level. The second firm now finds that it can charge a premium to consumers because they place a positive value on the fact that the price cost margin is used to purchase a public good. As a result, the second firm's profits rise above 0 and the sum of the profits of the two firms increase. This initial

effect is dampened because the increase in profits lowers $G'(L_I)$, but this secondary effect cannot outweigh the primary effect, and in the new equilibrium the sum of the profits of the two firms is higher.

If there is any degree of rivalry and group size L increases while holding m constant, by-product lobbying performs less well and breaks down entirely in large groups. By contrast, if the number of by-product lobbying firms m increases, holding L constant, the performance of by-product lobbying improves. In a larger society, we might expect to see more by-product firms, so in the next subsection, I analyze what happens when there is a simultaneous increase in group size and the number of by-product lobbying firms.

4.4. The Effect of a Simultaneous Increase in L and m .

While this paper does not present a theory of the determinants of the number of by-product firms, it seems plausible to assume that the number of by-product firms increases in proportion to the size of the society. Thus, I posit the following relationship between L and m :

$$m = \sigma L, \text{ where } 0 < \sigma < 1. \quad (23)$$

From equation (15) we now have

$$L_I = \alpha \sigma L \left(\frac{G'(L_I)}{L^\psi - G'(L_I)} \right). \quad (24)$$

Taking the derivative, we now have

$$\frac{dL_I}{dL} = \frac{\alpha \sigma G'(L_I) [(1-\psi)L^\psi - G'(L_I)]}{(L^\psi - G'(L_I))^2 - \alpha \sigma L^{1+\psi} G''(L_I)}. \quad (25)$$

The effective of an increase in L on $g = G(L_I)/L^\psi$ is given by the following derivative:

$$\frac{dg}{dL} = \left(\frac{LG'(L_I)(dL_I/dL) - \psi G(L_I)}{L^{1+\psi}} \right). \quad (26)$$

The first thing to note from (26) is that $dL_I/dL < 0$ is sufficient to ensure that $dg/dL < 0$. From (25), $G'(L_I) > (1-\psi)L^\psi$ is then sufficient for $dg/dL < 0$. Thus, for a fully rival good ($\psi = 1$), we are guaranteed that $dg/dL < 0$. Also note from (25) and (26) that for a pure public good ($\psi = 0$) we have $dg/dL > 0$. (Again, recall that $L^\psi > G'(L_I)$.) This analysis is summarized as Result 5:

Result 5: When $m = \sigma L$, (i) $dg/dL < 0$ if and only if $LG'(L_I)(dL_I/dL) - \psi G(L_I) < 0$; (ii) $dL_I/dL < 0$ is sufficient to ensure that $dg/dL < 0$; (iii) For a fully rival good ($\psi = 1$), $dg/dL < 0$; (iv) For a pure public good ($\psi = 0$), $dg/dL > 0$.

Since g is increasing in L for a pure public good and decreasing in L for a fully rival public good, this suggests that there is an interior cutoff of ψ such that g is increasing in L below this cutoff and decreasing in L above this cutoff. To gain more insight on this issue, it is helpful to return to the parametric example from section 3.3 in which $G(L_I) = L_I^\gamma$. Using (24), this gives the following solution for L_I :

$$L_I = \frac{\alpha\sigma\gamma L(L_I)^{\gamma-1}}{L^\psi - \gamma(L_I)^{\gamma-1}}. \quad (27)$$

It is still not possible to derive analytical results with this specific functional form, but we can get some insight from numerical simulations. Using equation (27), plus the relationship $g = L_I^\gamma/L^\psi$, I ran a large number of simulations in order to get insight on the comparative static dg/dL . The first thing to note concerning these simulations, is that while the parameters α and σ

affect the level of public good provision, they do not affect the sign of the comparative static.

This sign depends upon the parameters ψ and γ . The key finding from the numerical simulations is that $dg/dL < 0$ whenever $\psi > 0.5\gamma$ and $dg/dL > 0$ whenever $\psi < 0.5\gamma$. These relationships held for every numerical simulation that I ran which included values of γ throughout the range of 0 to 1. When $\psi > 0.5\gamma$, g fell as L increased, but, this movement was quite slow when ψ was only slightly in excess of 0.5γ .¹¹ As ψ increases beyond 0.5γ , the rate of decrease in the provision of the public good accelerates.

Speaking loosely, ψ has twice the power to turn dg/dL negative as γ has to turn it positive. Why? When ψ is larger, the public good exhibits greater rivalry, and this reduces consumer's willingness to pay a premium for the by-product good. Thus, L_I is lower. In addition, for any given level of L_I , $g = G(L_I)/L_I^\psi$ will be reduced when ψ is larger.

The results from the numerical simulations, plus the earlier results on the optimal level of provision of the public good suggest that there are three interesting ranges for the parameter ψ . If $\psi > \gamma$, g is decreasing in L under by-product lobbying, but the optimal level of provision g^o is not only decreasing in L , but decreasing to 0.¹² Thus, the failure of by-product lobbying in this parameter range is not a significant concern. If $\psi < 0.5\gamma$, g is rising in L . Thus, larger groups enjoy more of the public good, and by-product lobbying can be said to perform at least reasonably well in this range. In the simulations, I also computed g^o , and the gap between g and g^o grew quite sharply in the range $\psi < 0.5\gamma$. Thus, by-product lobbying is feasible in this range, but it will not necessarily produce anything close to the optimal level of the public good.

The most problematic range for by-product lobbying is when $0.5\gamma < \psi < \gamma$, as in this range g is declining in L , while g^o is increasing in L . Based on the numerical results, $\psi > 0.5$ is

sufficient for $dg/dL < 0$, since $\gamma < 1$. The empirical work of Borcharding and Deacon (1972) and Bergstrom and Goodman (1973) indicates that publically provided goods do in fact exhibit a high degree of rivalry.¹³ This suggest important limitations on the range of public goods which can feasibly be provided by by-product firms.

4.5. The Stigler Critique of the By-product Theory

Stigler's critique of Olson's by-product theory receives limited support from the model. There are conditions under which Stigler is correct. In particular, if there is a large group and the public good exhibits at least a moderate degree of rivalry, then by-product firms will not be successful. On the other hand, if the number of by-product firms increases in proportion to the size of the society and the degree of rivalry of the public good is low, by-product lobbying can succeed. Stigler emphasized the role of competition in his critique, and this is part of the story. If there is true monopoly power, then by-product firms can provide public goods regardless of the degree of rivalry. The reason is that the firm can use its monopoly profits to provide the public good, even if consumers are unwilling to pay a premium to obtain the private good. However, competition is only part of the story. Competition needs to be combined with a sufficiently high degree of rivalry in order to ensure that by-product lobbying fails in a large group. If these conditions are not met, then it is feasible for by-product firms to provide public goods.

5. Conclusion

It is important to try and understand how well by-product firms performs in the presence of goods which are at least partially rival, since many publically provided goods do in fact exhibit

¹¹ In some of the simulations, I allowed L to rise to 7 billion. If, say, γ is 0.8 and ψ is 0.401, then an increase in L from 10,000 to 7 billion has a rather small effect in reducing output of the public good.

¹² The numerical results revealed that under by-product lobbying, g also goes to zero in this range.

¹³ Publically provided goods such as police and fire protection clearly exhibit a high degree of rivalry.

some degree of rivalry. The results of this paper suggests important limitations upon the domain for which by-product lobbying (or corporate social responsibility) can be effective. In particular, if the degree of rivalry is at least moderately high, the results indicate that by-product firms will not be very successful at providing public goods in large groups. However, if the degree of rivalry is small, and the number of by-product firms increases in proportion with the size of the society, by-product firms may achieve a degree of success. In particular, in this circumstance, the level of provision of the public good will increase with group size.¹⁴ Since certain goods, particularly certain environmental goods, may exhibit a small degree of rivalry, by-product firms can succeed in providing these goods, even for a large group.¹⁵ In addition, it has long been recognized that by-product firms can succeed if they attain a position of true monopoly power (Sandler, 1992: 60). This suggests a moderate scope for by-product firms to succeed in providing public goods to large groups.

¹⁴ However, there is no presumption that the level of provision will be close to the optimum.

¹⁵ For example, the public benefit of eating dolphin safe tuna is not appreciably affected by an increase in group size.

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