Reduced Prizes and Increased Effort in Contests[+]

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Abstract

We study the general class of two-player public-policy contests and specify the asymmetry condition under which a more restrained government intervention that reduces the contestants' prizes has the "perverse" effect of increasing their aggregate lobbying efforts.

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I. Introduction

Patent races, tournaments, conflict and struggles over monopoly status, minimum wage, environmental policy or trade policy have been modeled as contests in which participants exert efforts to increase their probability of winning a prize. A significant element in such contests is the function that provides each player's probability of winning for any given combination of the efforts made by the contestants, the so called contest success function (CSF). The two most commonly used CSFs are Tullock's (1980) logit-form function and the function used in all-pay auctions that awards the prize to the most active rent seeker.

A major concern in the contest literature has been the issue of how do changes in the parameters of the contest (number, valuations and abilities of the contestants and the nature of the information they have) affect their equilibrium efforts and the extent of relative prize dissipation, Hillman and Riley (1989), Hurley and Shogren (1998), Konrad (2002), Nitzan (1994) and Nti (1997). In addition, attention has been paid to the effect of changes in these parameters on the contestants' expected payoffs, Baik (1994), Gradstein(1995) and Nti (1997). The main concern of this study is the clarification of the effect of changes in public policy that determine the prize system on the total effort invested by the contestants.

The main objective of our paper is to clarify why a more restrained government intervention that directly reduces the prizes of the two contestants may have the "perverse" effect of increasing their total exerted efforts.

II. The Public Policy Contest

There are two risk-neutral interest groups (*L* and *H*) that are differently affected by the approval and rejection of a proposed policy[1]. The interest groups engage in a complete-information contest that determines the probabilities of approval and rejection of the proposed policy.[2]

Player *i*'s preferred policy is approved in probability Pr_i. n_i denotes the stake of player *i* (his real benefit from winning the contest), (Baik, 1999 and Epstein and Nitzan, 2002, 2003a, 2003b). A player's stake is secured when he wins the contest,

[1] Epstein and Nitzan (2002).

[2] Modeling the contestants as single agents presumes that they have already solved the collective action problem.

that is, when his preferred policy is the outcome of the contest. For one player the desirable outcome is associated with the approval of the proposed policy, *I*, while for the other player the desirable outcome is realized when the proposed policy is rejected. x_i denotes the effort of the risk-neutral player *i*. The expected net payoff (surplus) of interest group *i*:

(1) $$E(w_i) = \Pr_i n_i(I) - x_i$$

As in Skaperdas (1992), it is assumed that $\frac{\partial \Pr_i(x_i, x_j)}{\partial x_i} > 0$, $\frac{\partial \Pr_i(x_i, x_j)}{\partial x_j} < 0$ and given x_j, there exists $\underline{x}_i$ such that, for $x_i \geq \underline{x}_i$, $\frac{\partial^2 \Pr_i(x_i, x_j)}{\partial x_i^2} < 0$ [3] [4] (the latter inequality ensures that the second order conditions are satisfied). Since $\Pr_i(x_i, x_j) + \Pr_j(x_j, x_i) = 1$,

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[3] $\Pr_i(x_i, x_j)$ is referred to as a contest success function (CSF). The CSF's assumed in the literature, (Nitzan, 1994 and Skaperdas (1996), satisfy these assumptions.

[4] To secure existence and uniqueness of a pure strategy equilibrium, we assume that the conditions specified in Skaperds (1992) are satisfied. A sufficient condition for the uniqueness of equilibrium is:

$$\Pr_i(x_i, x_j)(1 - \Pr_i(x_i, x_j))\frac{\partial^2 \Pr_i(x_i, x_j)}{\partial x_i \partial x_j} + (2\Pr_i(x_i, x_j) - 1)\frac{\partial \Pr_i(x_i, x_j)}{\partial x_i}\frac{\partial \Pr_i(x_i, x_j)}{\partial x_j} = 0$$

For this condition to be satisfied, we have to make an additional plausible assumption; namely, that $\frac{\partial^2 \Pr_i(x_i, x_j)}{\partial x_i \partial x_j} \overset{>}{\underset{<}{=}} 0$ *iff* $\Pr_i(x_i, x_j) \overset{>}{\underset{<}{=}} 0.5$. This assumption means that player *i* has an advantage in terms of ability if a change in *j*'s effort positively affects his marginal winning probability. In other words, a positive (negative) sign of the cross second-order partial derivative of $\Pr_i(x_i, x_j)$, $\frac{\partial^2 \Pr_i}{\partial x_j \partial x_i}$, implies that *i* has an advantage (disadvantage) when *j*'s effort changes. Note that given these conditions the results of the paper still hold.

(2) $$\text{for } i \neq j, \quad \frac{\partial^2 \Pr_i(x_i, x_j)}{\partial x_i \partial x_j} = -\frac{\partial^2 \Pr_j(x_j, x_i)}{\partial x_i \partial x_j}.$$

The ability of a contestant j to convert effort into probability of winning the contest can be represented by the marginal effect of a change in his effort on his winning probability.

By assumption, both players participate in the contest (x_L and x_H are positive). Focusing on the unique interior Nash equilibria of the contest we obtain from the first order conditions $\left(\frac{\partial E(w_i)}{\partial x_i} = 0\right)$:

(3) $$\frac{\partial \Pr_i(x_i, x_j)}{\partial x_i} n_i(I) - 1 = 0 \quad \forall\ i \neq j \ \ and\ i, j = L, H$$

Thus[5] :

(4) $$\frac{\partial \Pr_i}{\partial x_i} = \frac{1}{n_i(I)}, \quad i = L, H$$

A change in the policy instrument I affects the stakes of the players and thus their efforts and their probability of winning the contest[6]. The introduction of the policy I enables us to analyze all the different type of changes in the stakes. In particular, it allows us to analyze a policy reform that affects (proportionally or not) the stakes of the two contestants or the stake of just one of them. Denoting the effect of a change in I on n_i by n'_i, $n'_i = \frac{\partial n_i}{\partial I}$, our subsequent analysis relates to all of the following five possible types of public-policy effects on the stakes of the interest groups:

[5] Second order conditions are satisfied.

[6] Note that the domain of the policy instrument I, the closed interval $I \in [\underline{I}, \overline{I}]$, may reflect economic feasibility or political feasibility.

Type	n'_i	n'_j
(i)	>0	<0
(ii)	>0	=0
(iii)	=0	<0
(iv)	>0	>0
(v)	<0	<0

In reforms of type (ii) and (iii), a change in I only affects the stake of one interest group. The incidence of the proposed policy reform in these cases is therefore partial. A change in I can be interpreted as a more (less) restrained government intervention if it reduces (increases) the affected stakes. Clearly, such a change also affects the stakes-asymmetry between the contestants. For example, in type (ii) reform where $i=H$, an increase in I represents a less restrained intervention that increases the asymmetry between the stakes of the contestants.

In the remaining types the incidence of the proposed reform is complete because a change in I affects the stakes of the two contestants. In reforms of type (i) a change in the policy instrument I has opposite effects on the stakes of the two players. If $i=H$, such a change positively affects the asymmetry between the stakes of the contestants. If $i=L$, the asymmetry between the stakes is inversely related to a change in I. In both cases a change in the proposed policy can be considered as a more restrained government intervention if it reduces the sum of the stakes $n_L + n_H$.

In reforms of type (iv) and (v) a change in I has a similar positive or negative effect on the stakes of the players. In both of these cases, therefore, such a change can be unambiguously interpreted as a more restrained or a less restrained government intervention. In these cases the effect of a change in I on the stakes-asymmetry depends on the relationship between the elasticities of the stakes with respect to I. Specifically, the effect of a change in I on n_L / n_H depends on whether $\frac{\eta_L}{\eta_H}$ is greater or smaller than 1, where $\eta_j = \frac{\partial n_j}{\partial I}\frac{I}{n_j}$, $j = L, H$. In a type (iv) reform the asymmetry in the stakes is positively related to a change in I if $\frac{\eta_L}{\eta_H}$<1. In a type (v) reform the asymmetry in the stakes is positively related to a change in I if $\frac{\eta_L}{\eta_H}$>1.

Suppose that the functions $n_i(I)$ are continuous and twice differentiable in I. The Nash equilibrium efforts satisfy:

$$(5) \quad \frac{\partial x^*_i}{\partial I} = \frac{n_i \frac{\partial^2 \Pr_i}{\partial x_i \partial x_j} \frac{\partial \Pr_j}{\partial x_j} \frac{\partial n_j}{\partial I} - n_j \frac{\partial^2 \Pr_j}{\partial x_j^2} \frac{\partial \Pr_i}{\partial x_i} \frac{\partial n_i}{\partial I}}{n_i n_j \left(\frac{\partial^2 \Pr_j}{\partial x_j^2} \frac{\partial^2 \Pr_i}{\partial x_i^2} - \frac{\partial^2 \Pr_i}{\partial x_i \partial x_j} \frac{\partial^2 \Pr_j}{\partial x_i \partial x_j} \right)} \quad , \; i \neq j, \;\; i, j = L, H$$

$X^* \; \left(= x_L^* + x_H^*\right)$ represents the rent dissipation. By (5) and (4):

$$(6) \qquad \frac{\partial X^*}{\partial I} = \frac{1}{B}\left(\frac{\partial^2 \Pr_H}{\partial x_H \partial x_L} \left(\eta_L n_H - \eta_H n_L \right) - \left(\frac{\partial^2 \Pr_H}{\partial x_H^2} \eta_L n_H + \frac{\partial^2 \Pr_L}{\partial x_L^2} \eta_H n_L \right) \right)$$

where $B = I \; n_i \, n_j \left(\frac{\partial^2 \Pr_j}{\partial x_j^2} \frac{\partial^2 \Pr_i}{\partial x_i^2} - \frac{\partial^2 \Pr_i}{\partial x_i \partial x_j} \frac{\partial^2 \Pr_j}{\partial x_i \partial x_j} \right) > 0$, $\eta_j = \frac{\partial n_j}{\partial I} \frac{I}{n_j}$ and all second-order partial derivatives are computed at the Nash equilibrium (x^*_H, x^*_L). The first term in (6) represents the sum of the two contestants' strategic rival's-stake effects. The sign of player *i*'s strategic rival's-stake effect is equal to the sign of $\frac{\partial^2 \Pr_i}{\partial x_i \partial x_j} \eta_j$.

The second term represents the sum of the two contestants' own-stake effects. The sign of player *i*'s own-stake effect is equal to the sign of η_i. By assumption, $\frac{\partial^2 \Pr_i(x_i, x_j)}{\partial x_i^2} < 0$ and, by (2), $\frac{\partial^2 \Pr_i(x_i, x_j)}{\partial x_i \partial x_j} \frac{\partial^2 \Pr_j(x_j, x_i)}{\partial x_i \partial x_j} < 0$. Hence, *B>0.*

Proposition:

$$\frac{\partial X^*}{\partial I} \begin{matrix} > \\ < \end{matrix} 0 \iff \frac{\partial^2 \Pr_H}{\partial x_H \partial x_L}\left(\eta_L n_H - \eta_H n_L\right) \begin{matrix} > \\ < \end{matrix} \frac{\partial^2 \Pr_H}{\partial x_H{}^2}\eta_L n_H + \frac{\partial^2 \Pr_L}{\partial x_L{}^2}\eta_H n_L$$

This proposition enables us to analyze how changes in the stakes, both stakes or just one stake, affect the total rent-seeking efforts. For example, when both stakes increase, then $n'_L, n'_H > 0$ and thus $\eta_L, \eta_H > 0$. However, if there is no change in the higher stake, but there is a decrease in the lower stake, then $n'_L < 0 \; and \; , n'_H = 0$ and, in turn, $\eta_L < 0 \; and \; \eta_H = 0$. The proposition therefore covers all the different possibilities of changes in the stakes as presented in the table above. The conditions resolving the ambiguity regarding the sensitivity of the rent dissipation to a proposed policy reform involve three elements of asymmetry between the contestants: $A^1{}_j = \frac{\partial^2 \Pr_j}{\partial x_j \partial x_i} \Big/ \left(\frac{\partial^2 \Pr_i}{\partial x_i{}^2}\right)$, $A^2{}_j = \frac{n_j}{n_i}$ and $A^3{}_j = \frac{\eta_j}{\eta_i}$. The condition clarifies the role of stakes-asymmetry and ability-asymmetry between the contestants. It implies that even under the most restrained policy reform, where $n'_H < 0$ and $n'_L < 0$, a reform that reduces the stakes of the two contestants, it is possible that the two contestants are induced to increase their aggregate effort. This occurs when the negative rival's-stake effect, $\frac{\partial^2 \Pr_i}{\partial x_i \partial x_j}\eta_j n_i$, of the contestant who is induced to increase his effort more than counterbalances the sum of the two positive own-stake effects, $\frac{\partial^2 \Pr_j}{\partial x_j{}^2}\eta_i \, n_j$, and his opponent's positive rival's stake effect. Alternatively, if the *L* player's effort is a substitute to the *H* player's effort, a sufficiently high reduction in the normalized stakes-asymmetry, a sufficiently high value of $A^3{}_H \big/ A^2{}_H$, would induce the *L* player to increase his effort such that aggregate effort is increased. When the *H* player's effort is a substitute to the *L* player's effort, a sufficiently small reduction in the normalized stakes-asymmetry, a sufficiently small value of $A^3{}_H \big/ A^2{}_H$, would induce the *H* player to increase his effort such that aggregate effort is increased.

An Example: The ambiguity of the counterintuitive effect of a change in both stakes on the efforts of the contestants is illustrated below using a plausible and widely used contest success function. Specifically, we present a situation where, under the same contest success function, a decrease in the stakes of the contestants may result in an increase or in a decrease in rent dissipation, *X*. Consider a generalized Tullock's (1980) lottery logit contest success function (CSF) (see Gradstein 1995 and Nti 1997) where $\Pr_L = \frac{x_L}{d\,x_H + x_L}$, $\Pr_H = \frac{dx_H}{d\,x_H + x_L}$ and $x_H, x_L, d > 0$. By the first order conditions (3) (or (4)) we obtain that in equilibrium $x^*{}_L = \frac{dn_H n_L{}^2}{(dn_H + n_L)^2}$ and $x^*{}_H = \frac{dn_L n_H{}^2}{(dn_H + n_L)^2}$. Therefore, in equilibrium the total rent seeking efforts are equal to: $X^* = x^*{}_L + x^*{}_H = \frac{dn_L n_H (n_L + n_H)}{(dn_H + n_L)^2}$. In this case $\frac{\partial X^*}{\partial n_L} > 0$ and $\frac{\partial X^*}{\partial n_H} \begin{smallmatrix} > \\ = \\ < \end{smallmatrix} 0$ *iff* $n_L \begin{smallmatrix} > \\ = \\ < \end{smallmatrix} (d-2)n_H$. This means that a decrease in the lower stake n_L reduces the effort of player L while a decrease in the higher stake $n_{H,}$ may increase or decrease the effort of player H. The effect of a simultaneous decrease of both stakes on the equilibrium total rent-seeking efforts X^* is therefore ambiguous. Using the conditions stated in the proposition, we can present cases under which such a simultaneous decrease in both stakes reduces or increases the rent seeking efforts. For example, let *d*=100, $n_L^0 = 100$ and $n_H^0 = 1{,}000$, in which case $X^* = 1.0978$. A decrease the stakes such that $n_L^1 = 90$ and $n_H^1 = 100$ **increases** the efforts to $X^* = 1.6796 > 1.0978$. However, if at the initial case *d*=100, $n_L^0 = 100$ and $n_H^0 = 110$, in which case $X^* = 1.874$, a simultaneous decrease in the stakes such that $n_L^1 = 90$ and $n_H^1 = 100$ results in **reduced** efforts as $X^* = 1.6796 < 1.874$. To sum up, this example demonstrates that changing both stakes in the same direction may increase or decrease the rent dissipation. The conditions that insure a decrease or an increase are those stated in the proposition.

III. Conclusion

Government intervention often gives rise to contests in which the possible prizes are determined by the existing status-quo and some new public-policy proposal. Focusing on a general class of two-player public-policy contests, we have examined the effect of a change in the proposed policy on the rent dissipation of the contestants. Our main result clarifies what are the asymmetry conditions under which a more restrained government intervention that reduces the contestants' prizes has the perverse effect of increasing their aggregate lobbying efforts. This result complements the findings of Baye et. al (1993), that were established in the context of all-pay auctions, and the findings of Che and Gale (1997), (1998), that were based on the assumption that rent seekers are budget constrained. While these scholars focused, respectively, on constraints on the set of contestants and on caps on lobbying expenditures as possible means of reducing the asymmetry between the contestants, we emphasize the role of public policy reforms in generating direct changes in stakes-asymmetry and indirect changes in ability-asymmetry between the contestants. In the context of an all-pay lobbying auction, a politician wishing to maximize political rent-seeking expenditures may find it in his best interest to exclude certain lobbyists who highly value the political prize from participating in the lobbying contest, Baye et. al. (1993). He may also find it in his best interest to impose budget constraints on the rent seekers, Che and Gale (1998) or, in the presence of such constraints, to operate in a political-economic environment that has a lower tolerance for rent seeking (influence activities are awarded less in such an environment), Che and Gale (1997). Our study clarifies that in a public-policy contest that allows a large family of CSFs, a politician may find it in his best interest to reduce government intervention that takes the form of reducing the stakes of the interest groups that correspond to the proposed public policy.

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