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Regulate us, please!: On strategic lobbying in cournot-nash oligopoly

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Regulate Us, Please!

On Strategic Lobbying in Cournot-Nash Oligopoly

by Peter Michaelis

May 1994

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On Strategic Lobbying in Cournot-Nash Oligopoly

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Abstract. Empirical studies on industry lobbying sometimes reveal that certain firms within an industry behave atypically in that they promote cost driving regulations like, e.g., environmental standards. For analysing this phenomenon of 'strategic lobbying', the present paper combines a heterogeneous Cournot-Nash oligopoly with a model of endogenous policy making where two parties compete for campaign contributions spent by the regulated industry. It is shown that the existence of potential regulation gains (and consequently the incentive for strategic lobbying activities) depends on the relationship between possible cost differentials and the market structure of the industry under consideration. Based on these results, the paper examines the effects of strategic lobbying for two different scenarios. The first scenario assumes that only one firm is engaged in lobbying, whereas the second scenario looks at simultaneous (competing) lobbying activities by several firms.

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1. Introduction

Industry lobbying usually aims at erecting entry barriers against potential (foreign) competitors or at preventing the introduction of costly regulations like, e.g., environmental standards. Most of the theoretical work on this issue assumes that the industry under consideration acts as a single coalition with the same interest.[1] In practice, however, it can sometimes be observed that certain firms *within* an industry behave atypically in that they lobby for a cost driving tightening of regulations.[2] As pointed out by Oster (1982), the explanation of such an - at first glance inconsistent - behaviour lies in the fact that administrative regulations often impose different costs on the firms within an industry. Consequently, for some of these firms it might pay to lobby for a tightening of regulations which would be to their own comparative cost advantage.

What is the appropriate theoretical framework for analysing this kind of strategic lobbying behaviour? In monopoly, there are no rivals to be hurt by a tightening of regulations, and perfect competition by definition prohibits any influence on the political process. Consequently, the natural habitat of strategic lobbying is oligopoly. Moreover, in order to give rise for *strategic* lobbying activities, there must be some differences between the oligopolists' cost structures. And finally, there must be some barriers to entry to the considered industry because otherwise any profits created by lobbying activities would be dissipated by the entry of new firms (see Oster, 1982). Hence, the economic part of a model for analysing strategic lobbying behaviour should portray a heterogeneous oligopoly that is - at least up to a certain degree - protected by barriers to entry.

The political part of a model for analysing strategic lobbying behaviour should cover the interactions between the political sector and the regulated industry as well as the interactions within the political sector. An approach particularly suited to match these requirements is the *interest-group-cum-electoral-competition approach* developed by Young and Magee (1986) and Austen-Smith (1987).[3] This approach extends the traditional rent-seeking models based on Tullock (1967) by introducing competition bet-

* I wish to thank Frank Stähler for helpful comments. Of course, the usual disclaimer applies.

1 See, e.g., Magee et al. (1989), Ursprung (1991), Bartsch et al. (1993) and Moore and Suranovic (1993). The only exception seems to be an earlier work of Oster (1982) that allows for different cost structures within the lobbying industry.This paper, however, remains on a more nontechnical level and the political sector is not explicitely modelled.

2 For empirical examples see, e.g., Oster (1982) on the american pharmaceuticals industry and *The Economist* (January 8, 1994) on the british the waste management industry.

3 For a review of the different approaches to modelling endogenous policy making in the presence of interest groups see Ursprung (1991).

ween political parties. The latter aim at maximising their probability of election that in turn depends on the amount of campaign contributions received from interest groups and other sources.

The remainder of the paper is organised as follows. Section 2 develops a model of endogenous policy making with industry lobbying that follows the line described above. Section 3 discusses the conditions that have to be satisfied in order to give rise for *strategic* lobbying activities. Based on these results, Section 4 analyses the case of unilateral lobbying by a single firm, and Section 5 analyses the case of competing lobbying activities. Section 6 closes the paper with some conclusions and prospects for further research.

2. The Model

Consider a situation of electoral competition between two parties $i=h,l$. Each of them announces a policy programme which includes a certain regulation (e.g., an emission standard) that imposes costs on the industry under consideration. The level of regulation proposed by party i is denoted by s_i. Party h, the 'high regulation'-party, prefers a higher level than party l, the 'low regulation'-party (i.e. $s_h>s_l$). Both parties, however, have to comply with a set of legal and technical constraints that constitutes a lower bound $\underline{s}\geq 0$ and an upper bound $\bar{s}>\underline{s}$ The probability of winning the election, w_i, depends on the share of campaign contributions Z_i received by party i (see, e.g., Ursprung, 1991):

$$(1) \qquad w_i = \begin{cases} x_i Z_i / (x_l Z_l + x_h Z_h) & \text{if } Z_l + Z_h > 0, \\ 0.5 & \text{if } Z_l + Z_h = 0. \end{cases}$$

The coefficient $x_i>0$ denotes the relative productivity of campaign contributions. E.g., $x_l>x_h$ would imply that one dollar spent by party l "buys more votes" than one dollar spent by party h. Campaign contributions Z_i are composed of z_i, the amount of financial support received from the industry under consideration, and z_i^0, the amount of financial support received from other sources: $Z_i=z_i^0+z_i$. It is assumed that there are no strategic interactions between the industry under consideration and other donors of campaign contributions. Consequently, z_h^0 and z_l^0 are exogenous, whereas z_h and z_l depend on the chosen level of regulation s_i. In determining s_i the parties play a Nash-game, i.e. each party chooses s_i as to maximise its probability of election, w_i, under the assumption that the other party's s_i is given. To connect this political part of the model with its economic part (see below), the analysis follows the seminal work of

Brock and Magee (1974) and assumes that the parties act as Stackelberg leader, i.e. in determining s_i they anticipate the lobbying payments from the regulated industry.

The industry under consideration is composed of two types of firms which produce a homogenous good: a single firm 1 that produces the output y_1 and n *identical* firms k=2,3,...,n+1 that produce the aggregate output ny_k. Market entry of potential competitors is restricted by entry barriers like, e.g., patent rights or licensing requirements. Production cost of firm j (j=1,k)[4] are composed of fixed cost $F_j \geq 0$ and constant marginal cost $c_j(s)$ that depend on the actual level of regulation: $\partial c_j(s)/\partial s>0$, $\partial^2 c_j(s)/\partial s^2 \geq 0$. Moreover, it is assumed that firm 1 employs a superior production technology which guarantees for any level of regulation $s \in [\underline{s}, \overline{s}]$ that firm 1 has lower marginal cost than its competitors, i.e. $c_1(s)<c_k(s)$.

Aggregate output is denoted by y and market demand is given by the linear inverse demand function $p(y)=a-b\cdot y$. For any given level of regulation s, each firm j maximises its profit $\pi_j(s)=[p(y)-c_j(s)]y_j-F_j$ by choosing y_j under the assumption that the output of the rest of the industry is given. Based on the outcome of this Cournot-Nash game, the firms engaged in lobbying determine their optimal level of campaign contribution by maximising their expected profit $w_l \cdot \pi_j(s_l)+w_h \cdot \pi_j(s_h)$ minus political outlays.

The overall structure of the present model is thus described by a two-stage game within the regulated industry and a one-stage game between the competing political parties, where both games are connected by the above Stackelberg assumption. In the following Section, the relationship between the level of regulation and the firms' profits in Cournot-Nash equilibrium will be derived. Based on these results, the model will be used to analyse strategic lobbying behaviour within two different scenarios: Section 4 assumes that only firm 1 is engaged in lobbying, whereas Section 5 analyses the case of simultaneous (competing) lobbying activities by all firms in the industry.

3. Regulation Gains and the Incentive for Strategic Lobbying

Profit maximisation by the firms leads to the reaction functions $y_1[y_k(s)]$ and $y_k[y_1(s)]$ which can be solved for the Cournot-Nash-equilibrium in output:[5]

$$(2) \quad y_1(s) = \frac{a+nc_k(s)-(n+1)c_1(s)}{b(n+2)} \quad , \quad y_k(s) = \frac{a+c_1(s)-2c_k(s)}{b(n+2)} .$$

[4] Note that the index 'j' refers to *all* firms j=1,2,..,n+1, whereas the index 'k' refers only to the n identical firms k=2,3,..,n+1.

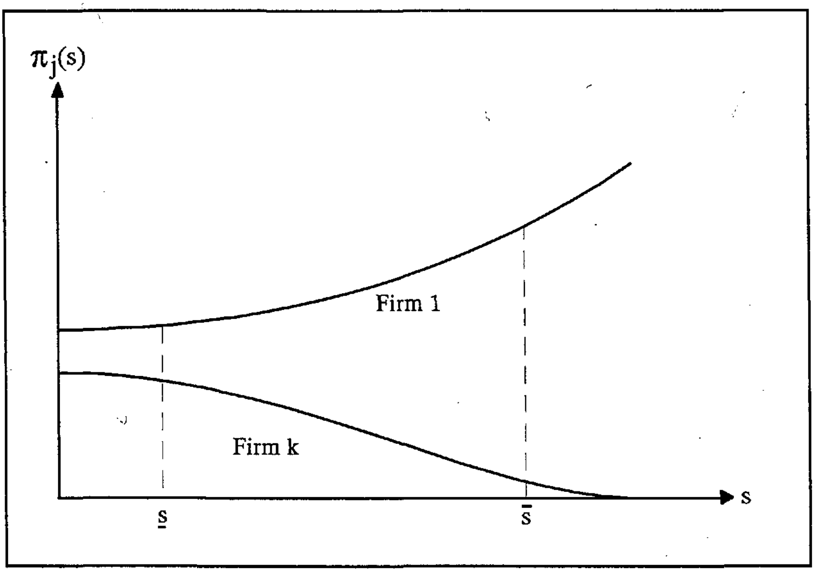
[5] For ease of notation, the optimal values of variables are not marked by additional symbols.

Assuming $a>[(n+2)(bF_k)^{1/2}+2c_k(s)-c_1(s)]$ guarantees an interior solution with non negative profits that are given by $\pi_j(s) = by_j(s)^2-F_j$. Differentiating $\pi_1(s)$ with respect to s reveals that firm 1 gains from a marginal tightening in regulation (i.e. $d\pi_1(s)/ds>0$) if the ratio between marginal compliance cost satisfies the following condition:

$$(3) \quad \frac{\partial c_k(s)/\partial s}{\partial c_1(s)/\partial s} > \frac{n+1}{n}.$$

Hence, the existence of regulation gains and consequently the incentive for strategic lobbying depends on the relationship between market structure and compliance cost: The more atomised are the competitors (i.e. the larger is n), the smaller is the cost advantage of firm 1 that is needed to create an incentive for strategic lobbying. The economic reasons for this link between market structure and lobbying behaviour are obvious: A tightening in regulation leads not only to a direct cost-increasing effect but also to a rearrangement of market shares in favour of firm 1 that produces more efficient. For a sufficiently large number of competing firms (or for a sufficiently large cost advantage, respectively), this increase in market share outweighs the direct effect on costs such that the firm 1 gains gain from of a marginal tightening in regulation.

Figure 1. Regulation Gains in Cournot-Nash Equilibrium.



However, in combining this result with the lobbying approach introduced in the last Section, one caveat should be recognised: In general, it cannot be expected that $\pi_1(s)$ is monotonous in s, such that the above derived condition (3) applies only to *marginal* changes in a *given* level of regulation, but it cannot readily be used to compare two distinct levels s_i proposed by the two political parties. To overcome this possible inconsistency, the remainder of the analysis assumes that the firms' compliance costs can be described by exponential functions $c_j(s)=c_j s^\gamma$ with $c_k>(n+1/n)c_1>0$ and $\gamma\geq1$. This specification guarantees not only monotonicity of $\pi_j(s)$, but it also facilitates an explicit solution to the firms' maximisation problem.[6] Figure 1 shows the resulting profit functions.

4. Unilateral Lobbying Activities

This Section assumes that only firm 1 is able to influence the political process by campaign contributions. The analysis will proceed in two steps. The first step determines the optimal level of campaign contributions spent by firm 1, the second step analyses the political equilibrium which results under Stackelberg behaviour by the two parties.

Optimising Lobbying Payments

In order to identify the optimal level of campaign contribution, firm 1 maximises its expected profit $w_h(z_h)\cdot\pi_1(s_h)+(1-w_h(z_h))\cdot\pi_1(s_l)$ minus political outlays z_h. Differentiating the corresponding Lagrangean yields the following Kuhn-Tucker-condition:

$$\text{(4)}\qquad \frac{\partial w_h}{\partial z_h}\cdot\hat{\pi}_1(s_h,s_l)\begin{cases}=1 & \text{if } z_h>0,\\ \leq 1-\lambda & \text{if } z_h=0.\end{cases}$$

Here, $\lambda\geq0$ is the multiplier associated with the non-negativity condition $z_h\geq0$, and $\hat{\pi}_1(s_h,s_l)$ is the difference in profits under the two policies, i.e. $\pi_1(s_h)$-$\pi_1(s_l)$. The LHS of (4) thus represents the change in expected profits caused by a marginal increase in campaign contributions. Consequently, condition (4) states that for an equilibrium in the interior (i.e. $z_h>0$) marginal cost and benefits of lobbying are balanced: The last Dollar spent on campaign contributions yields an increase in expected profits of just one Dollar. Differentiating (1) with respect to z_h, condition (4) can be solved for the optimal amount of campaign contributions:

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6 To avoid problems associated with market exit it migth further be assumed that the upper bound of the regulation level is small enough such that $\pi_k(\bar{s})$ would still be non negative.

$$(5) \qquad z_h(s_h,s_l)=\begin{cases}\dfrac{1}{x_h}\left[\sqrt{x_h x_l z_l^o \hat{\pi}_1(s_h,s_l)}-x_l z_l^o\right]-z_h^o & \text{if } \hat{\pi}_1(s_h,s_l)>\Omega(z_l^o,z_h^o),\\ 0 & \text{if } \hat{\pi}_1(s_h,s_l)\le\Omega(z_l^o,z_h^o).\end{cases}$$

Equation (5) shows that firm 1's incentive for strategic lobbying is driven by the difference in profits $\hat{\pi}_1(s_h,s_l)$. However, it also turns out that a positive $\hat{\pi}_1(s_h,s_l)$ alone does not necessarily imply $z_h>0$: Firm 1 will spend campaign contributions only if $\hat{\pi}_1(s_h,s_l)$ is sufficiently large compared to the parties' exogenous financial endowments z_i^o that determine the 'choke off'-level $\Omega(z_l^o,z_h^o)$:[7]

$$(6) \qquad \Omega(z_l^o,z_h^o):=\left(\left.\frac{\partial w_h}{\partial z_h}\right|_{z_h=0}\right)^{-1}=\frac{(x_l z_l^o+x_h z_h^o)^2}{x_l x_h z_l^o},$$

Furthermore, (5) indicates that the 'effective' financial power of party *l*, $x_l z_l^o$, plays an ambiguous role: For $x_l z_l^o<x_h(1/4)\hat{\pi}_1(s_h,s_l)$ condition (5) implies $\partial z_h/\partial z_l^o>0$, i.e. an exogenous increase in z_l^o encourages firm 1 to spend *more* campaign contributions on party *h*. However, if $x_l z_l^o$ exceeds the critical level $(1/4)x_h\hat{\pi}_1(s_h,s_l)$, the reverse becomes true, i.e. an increase in z_l^o discourages firm 1 in its lobbying behaviour.

Political Equilibrium under Stackelberg-Behaviour

Both parties aim at maximising their probability of election, w_i, taking into account firm 1's lobbying behaviour as derived above. Assuming an interior solution, equations (1) and (5) yield the following relationship between w_h and s_i:

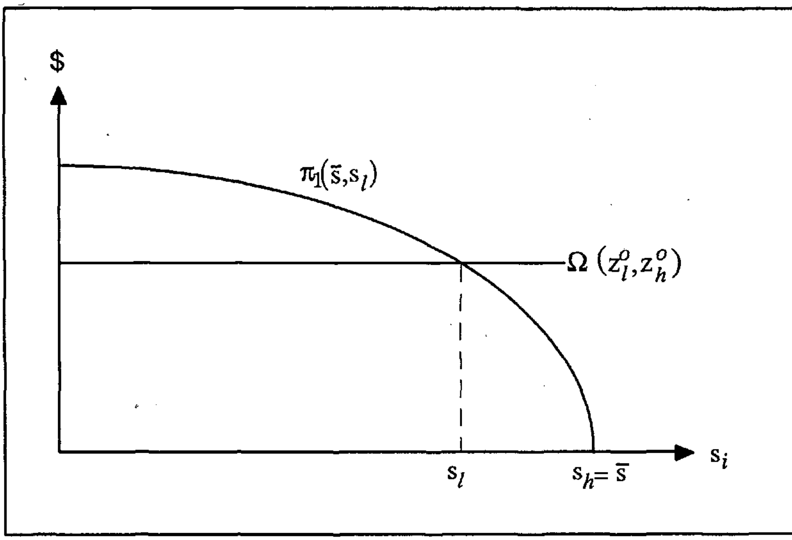
$$(7) \qquad w_h(s_h,s_l)=1-\sqrt{x_l z_l^o/\hat{\pi}_1(s_h,s_l)}$$

According to (7), maximising w_h for a given s_l requires to maximise $\pi_1(s_h)$. Hence, party *h* will *always* choose the upper bound $\bar{s}$ which yields the highest possible profit for firm 1 (see Figure 1). However, party *l* knows that any payment from firm 1 to party *h* would deteriorate w_l. Consequently, party *l* will move towards party *h*'s equilibrium position $s_h=\bar{s}$ until $\hat{\pi}_1(s_h,s_l)$ shrinks down to $\Omega(z_l^o,z_h^o)$, such that firm 1 has no more incentive to spend campaign contributions. The equilibrium position of party *l* thus satisfies the condition $\hat{\pi}_1(s_h,s_l)=\Omega(z_l^o,z_h^o)$ as shown in Figure 2. Consequently, the location of the political equilibrium depends on the market conditions (demand curve,

[7] As indicated by (6), $\hat{\pi}_1(s_h,s_l)>\Omega(z_l^o,z_h^o)$ implies that the *first* Dollar spent on campaign contributions must yield more than one Dollar increase in expected profits.

cost structures, number of firms) determining $\hat{\pi}_1(s_h,s_l)$ as well as on the parties exogenous financial endowments determining $\Omega(z_l^o,z_h^o)$. For given market conditions (i.e. for a given $\hat{\pi}_1(s_h,s_l)$), the difference between the two equilibrium positions depends only on the parties' exogenous financial endowments: Party l will move the closer towards party h, the smaller is $\Omega(z_l^o,z_h^o)$. Consequently, the existence of exogenous financial sources serves as a corrective that restricts the lobbying firm's influence on the political equilibrium.

Figure 2. Political Equilibrium in the Case of Unilateral Lobbying.



To sum up, in the case of unilateral lobbying Stackelberg behaviour by the parties leads to concordance in the extreme: The high regulation party will propose the maximum level $\bar{s}$, and the low regulation party will move towards this position until the lobbying firm has no more incentive to spend campaign contributions (given the parties exogenous financial support). This outcome is highly comfortable for the lobbying firm since it implies that in the political equilibrium there is in fact no need for positive lobbying payments. Instead, the mere threat of lobbying payments is sufficient to discipline both parties. This situation, of course, changes completely if one considers the case of *competing* lobbying activities which will be analysed in the next Section.

5. Competing Lobbying Activities

In the case of competing lobbying activities, firm 1 will support the high regulation party, whereas firms k=2,3,..,n+1 will support the low regulation party. Denoting firm j's campaign contribution by z_j, this implies $z_h = z_1$ for party *h* and $z_l = n \cdot z_k$ for party *l*.

Optimising Lobbying Payments

In determining the optimal amount of lobbying payments, each firm j maximises its expected profit minus political outlays under the assumption that the other firm's campaign contributions are given.[8] This Nash game leads to the reaction functions:

$$(8) \quad z_1(z_k) = \frac{1}{x_h}\left[\sqrt{x_h x_l (z_l^o + n \cdot z_k)\hat{\pi}_1(s_h, s_l)} - x_l(z_l^o + n \cdot z_k)\right] - z_h^o,$$

$$z_k(z_1) = \frac{1}{n \cdot x_l}\left[\sqrt{x_h x_l (z_h^o + z_1)\hat{\pi}_k(s_h, s_l)} - x_h(z_h^o + z_1)\right] - \frac{z_l^o}{n},$$

where $\hat{\pi}_k(s_h,s_l)$ denotes the (positive) difference in profits $\pi_k(s_l)-\pi_k(s_h)$.[9] Inserting $z_h=z_1$ and $z_l=n \cdot z_k$, these reactions functions can be reformulated in terms of z_h and z_l:

$$(9) \quad z_h(z_l) = \frac{1}{x_h}\left[\sqrt{x_h x_l (z_l^o + z_l)\hat{\pi}_1(s_h, s_l)} - x_l(z_l^o + z_l)\right] - z_h^o,$$

$$z_l(z_h) = \frac{1}{x_l}\left[\sqrt{x_h x_l (z_h^o + z_h)\hat{\pi}_k(s_h, s_l)} - x_h(z_h^o + z_h)\right] - z_l^o.$$

These functions describe the interdependencies between the amount of campaign contributions received by the two parties. Again, the differences in profit, $\hat{\pi}_j(s_h,s_l)$, turn out to be the driving force behind lobbying payments. Moreover, by calculating the slope of $z_h(z_l)$, it can be shown that a marginal increase in the financial support enjoyed by party *l* provokes firm 1 to spent *more* campaign contributions on the competing party *h* as long as the effective financial power of party *l*, $x_l(z_l+z_l^o)$, does not exceed $(1/4)x_h\hat{\pi}_1(s_h,s_l)$. Beyond this critical level, however, an increase in z_l causes firm 1 to *reduce* its payments to party *h*. Analogous discouragement and encouragement effects apply to the lobbying behaviour of the other firms (see Figure 3).

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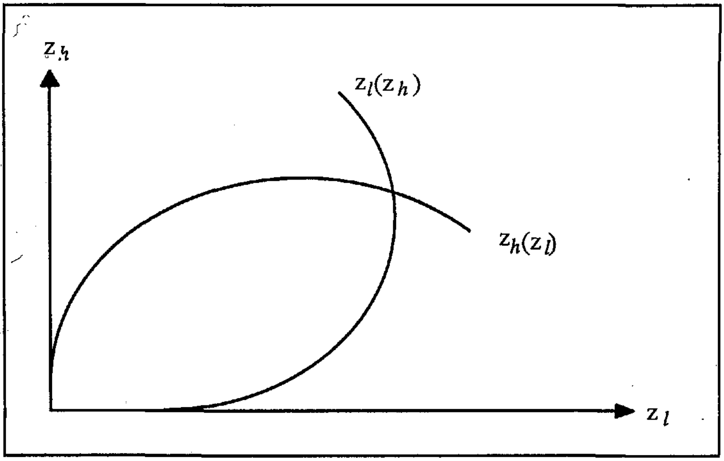
[8] It it should carefully be noted that this game structure implies that the firms k=2,3,..,n+1 are not able to coordinate their campaign contributions with each other.

[9] For simplicity, this Section neglects boundary solutions. The conditions to be satisfied for an interior solution are analogous to those discussed in the last Section.

Figure 3. Strategic Interdependencies Between the Parties' Lobbying Earnings.



Before proceeding to calculate the Nash equilibrium in lobbying payments, it should be noted that the reaction curves' intersections with the axis depend on the model parameters. In the special case of $z_l^o = z_h^o = 0$ (i.e. no exogenous financial support), both reaction curves pass through the origin such that they intersect each other twice. However, as indicated by (1), the intersection in the origin can be no equilibrium:[10] If there are no exogenous financial sources and firm 1 does not lobby at all (i.e. z_h=0), the other firms are always better off, if they marginally invest in lobbying. Hence, there exists a unique equilibrium in lobbying payments that is given by:

$$(10)\quad z_h = \frac{x_h x_l \hat{\pi}_1(s_h,s_l)^2 \hat{\pi}_k(s_h,s_l)}{\left[x_h \hat{\pi}_1(s_h,s_l) + x_l \hat{\pi}_k(s_h,s_l)\right]^2} - z_h^o, \qquad z_l = \frac{x_h x_l \hat{\pi}_1(s_h,s_l) \hat{\pi}_k(s_h,s_l)^2}{\left[x_h \hat{\pi}_1(s_h,s_l) + x_l \hat{\pi}_k(s_h,s_l)\right]^2} - z_l^o.$$

Political Equilibrium under Stackelberg behaviour

Again, both parties aim at maximising their probability of election taking into account the firms' lobbying payments as derived above. Inserting (10) into equation (1) yields the following relationship between the parties political programme and their probability of election:

10 Bartsch et al. (1993) have recently analysed a model on environmental legislation and lobbying that can be viewed as a simplified version of the above special case.

$$(11)\quad w_h(s_h,s_l)=\frac{x_h\hat{\pi}_1(s_h,s_l)}{x_h\hat{\pi}_1(s_h,s_l)+x_l\hat{\pi}_k(s_h,s_l)},\qquad w_l(s_h,s_l)=\frac{x_l\hat{\pi}_k(s_h,s_l)}{x_h\hat{\pi}_1(s_h,s_l)+x_l\hat{\pi}_k(s_h,s_l)}.$$

Hence, in choosing s_h, party *h* has to recognise that for a given s_l an increase in s_h raises $\hat{\pi}_1(s_h,s_l)$ as well as $\hat{\pi}_k(s_h,s_l)$. Consequently, increasing s_h raises *both* parties' lobbying earnings. Which one of these two opposite effects on w_h dominates, depends on the respective elasticities:

$$(12)\quad sign\left\{\frac{dw_h(s_h,s_l)}{ds_h}\right\}=sign\left\{\frac{\partial\hat{\pi}_1(s_h,s_l)}{\partial s_h}\frac{s_h}{\hat{\pi}_1(s_h,s_l)}-\frac{\partial\hat{\pi}_k(s_h,s_l)}{\partial s_h}\frac{s_h}{\hat{\pi}_k(s_h,s_l)}\right\}.$$

The appendix proofs that for $s_h>s_l$ the elasticity of $\hat{\pi}_1(s_h,s_l)$ always exceeds the elasticity of $\hat{\pi}_k(s_h,s_l)$, such that dw_h/ds_h is always positive. Consequently, party *h* will again chose the upper bound $\bar{s}$ which yields the highest possible profit for its clientele. Analogously, it can be shown that dw_l/ds_l is always negative such that party *l* will always chose the lowest possible level of regulation, i.e. $s_l=\underline{s}$. Hence, the parties equilibrium positions imply a kind of 'maximum product differentiation' with respect to their political programmes. This outcome corresponds to Ursprung (1991) who shows within a related interest-group approach that Stackelberg behaviour by political parties can give rise to a process of *political polarisation* which cannot be explained by the traditional median voter approach (see, e.g., Downs, 1957).

Finally, it may be asked which of the parties will be the winner of the above lobbying game. Denoting the parties' *initial* probability of election by $w_i^o:=x_iz_i^o/(x_lz_l^o+x_hz_h^o)$, condition (11) implies that the net effect of the firms' competing lobbying activities will increase the high regulation party's probability of election if the ratio between the firms' incentive for lobbying exceeds the ratio between the parties' exogenous financial endowments: $\hat{\pi}_1(\bar{s},\underline{s})/\hat{\pi}_k(\bar{s},\underline{s})>z_h^o/z_l^o\Leftrightarrow w_h(\bar{s},\underline{s})>w_h^o$. Using the profit functions derived in Section 2, the ratio $\hat{\pi}_1(\bar{s},\underline{s})/\hat{\pi}_k(\bar{s},\underline{s})$ can be written as:

$$(14)\quad \hat{\pi}_1(\bar{s},\underline{s})/\hat{\pi}_k(\bar{s},\underline{s})=\frac{[nc_k-(n+1)c_1][\bar{s}^\gamma-\underline{s}^\gamma]+[nc_k-(n+1)c_1]^2[\bar{s}^{2\gamma}-\underline{s}^{2\gamma}]}{[2c_k-c_1][\bar{s}^\gamma-\underline{s}^\gamma]-[c_1-2c_k]^2[\bar{s}^{2\gamma}-\underline{s}^{2\gamma}]}.$$

Differentiating (14) with respect to n reveals that $\hat{\pi}_1(\bar{s},\underline{s})/\hat{\pi}_k(\bar{s},\underline{s})$ is monotonously increasing in n. Consequently, for given exogenous financial support and for a given cost differential, the final winner of the lobbying game depends on the market structure of the regulated industry: An increase in the high (low) regulation party's probability of election is the more likely, the higher (lower) is the number of competing firms.

6. Conclusions

For analysing strategic industry lobbying, the present paper has combined a heterogeneous Cournot-Nash oligopoly with a model of endogenous policy making where a 'high regulation'-party *h* and a 'low regulation'-party *l* compete for campaign contributions spent by the regulated industry. The model assumes that all firms are identical except firm 1 that has lower marginal compliance costs than its competitors. As a result, the existence of potential regulation gains - and consequently the incentive for strategic lobbying behaviour - depends on the firm's cost advantage and on the number of its competitors. Based on this outcome, the paper has examined the effects of strategic lobbying behaviour for two different scenarios:

- The first scenario assumes that only firm 1 is able to influence the political process by campaign contributions. In this case, Stackelberg behaviour by the parties leads to 'concordance in the extreme': Party *h* will propose the maximum possible level of regulation and party *l* will move towards this position until the firm 1 has no more incentive to spend campaign contributions. Hence, in equilibrium the *mere threat* of lobbying payments is sufficient to control both parties up to a certain degree.
- The second scenario assumes that not only firm 1 but also its competitors are engaged in simultaneous (competing) lobbying activities. In this case, Stackelberg behaviour by the parties leads to 'political polarisation': Party *l* will propose the lowest and party *h* will propose the highest possible level of regulation. Which of the parties will be the ultimate winner of this contest for campaign contributions, depends on firm 1's cost advantage as well as on the number of its competitors.

Finally, it should be noted that the above results rely on the assumption of a *given* market structure. As discussed in Section 1, industry lobbying cannot be explained without assuming a certain degree of entry barriers. But nevertheless, one generally cannot exclude that a change in regulations may change the market structure by attracting new firms or by driving out some of the old firms. A possible route to incorporate an endogenous market structure into the present model would be to assume free entry to the group of firms employing the old technology. In this case, the number of firms in the latter subgroup always satisfies the non-profit condition, such that any gains from lobbying would be dissipated by the entry of new firms. As a consequence, only the firm employing the superior (protected) technology has an incentive for lobbying activities. The determination of the optimal level of campaign contributions, however, becomes more demanding because the lobbying firm has to take into account that a change in regulation would lead to a change in the number of competing firms.

Appendix

For ease of notation, the condition to be proven is written as $\varepsilon_1(s_h,s_l)>\varepsilon_k(s_h,s_l)$ with:

$$\text{(A.1)}\quad \varepsilon_1(s_h,s_l):=\frac{\partial\hat{\pi}_1(s_h,s_l)}{\partial s_h}\cdot\hat{\pi}_k(s_h,s_l),\qquad \varepsilon_k(s_h,s_l):=\frac{\partial\hat{\pi}_k(s_h,s_l)}{\partial s_h}\cdot\hat{\pi}_1(s_h,s_l).$$

For any given $s'_h>0$, $\varepsilon_j(s_h,s_l)$ can be considered as a (decreasing) function of s_l. Inserting the profit functions derived in Section 2, differentiating with respect to s_l yields:

$$\text{(A.2)}\quad \varepsilon_1(s'_h,s_l)=\left\{2\gamma e_1 s_h'^{\gamma-1}\left(a+e_1 s_h'^{\gamma}\right)\left[\left(a-e_k s_l^{\gamma}\right)^2-\left(a-e_k s_h'^{\gamma}\right)^2\right]\right\}(9b)^{-2}>0,$$

$$\varepsilon_k(s'_h,s_l)=\left\{2\gamma e_k s_h'^{\gamma-1}\left(a-e_k s_h'^{\gamma}\right)\left[\left(a+e_1 s_h'^{\gamma}\right)^2-\left(a+e_1 s_l^{\gamma}\right)^2\right]\right\}(9b)^{-2}>0,$$

$$\text{(A.3)}\quad \partial\varepsilon_1(s'_h,s_l)/\partial s_l=-\left\{4\gamma^2 e_1 s_h'^{\gamma-1} e_k s_l^{\gamma-1}\left(a+e_1 s_h'^{\gamma}\right)\left(a-e_k s_l^{\gamma}\right)\right\}(9b)^{-2}<0,$$

$$\partial\varepsilon_k(s'_h,s_l)/\partial s_l=-\left\{4\gamma^2 e_1 s_h'^{\gamma-1} e_k s_l^{\gamma-1}\left(a-e_k s_h'^{\gamma}\right)\left(a+e_1 s_l^{\gamma}\right)\right\}(9b)^{-2}<0,$$

with $e_1:=n\cdot c_2-(n+1)c_1$ and $e_k:=2c_2-c_1$. Due to the assumption $a>e_k\cdot s^{\gamma}$ (see Section 3), $\varepsilon_j(s'_h,s_l)$ is positive, whereas its first derivative $\partial\varepsilon_j(s'_h,s_l)/\partial s_l$ is negative.

The proof of $\varepsilon_1(s_h,s_l)>\varepsilon_k(s_h,s_l)$ will proceed in five steps. The first step shows that $\varepsilon_1(s'_h,s_l)>\varepsilon_k(s'_h,s_l)$ for $s_l=0$; the second step shows that $\varepsilon_1(s'_h,s_l)$ is always steeper than $\varepsilon_k(s'_h,s_l)$; the third step shows that $\varepsilon_1(s'_h,s_l)$ and $\varepsilon_k(s'_h,s_l)$ have a common tangent in $s_l=s'_h$ with $\varepsilon_1=\varepsilon_2=0$; the fourth step shows that $\varepsilon_k(s'_h,s_l)$ is concave, and the fifth step shows that there exist a $\hat{s}_l>0$ such that $\varepsilon_1(s'_h,s_l)$ is concave for $s_l<\hat{s}_l$ and convex for $s_l>\hat{s}_l$. Combining together these five steps imply that there can be no intersection between $\varepsilon_1(s'_h,s_l)$ and $\varepsilon_k(s'_h,s_l)$ for $s_l<s'_h$ such that $\varepsilon_1(s'_h,s_l)>\varepsilon_k(s'_h,s_l)$ (see Figure A.1). This line of argumentation holds for any given $s'_h>0$.

Step 1. According to (A.2), $\varepsilon_1(s'_h,0)>\varepsilon_k(s'_h,0)$ requires: $e_1(a+e_1 s_h'^{\gamma})(a^2-(a-e_k s_h'^{\gamma})^2)>e_k(a-e_k s_h'^{\gamma})((a+e_1 s_h'^{\gamma})^2-a^2)$. Multiplying, cancelling of identical terms and dividing by $a e_1 e_k s_h'^{2\gamma}$ yields: $2e_1-e_2>e_1-2e_2$. For $c_2>c_1$, this condition is satisfied.

Step 2. Due to (A.2), $|\partial\varepsilon_1(s'_h,s_l)/\partial s_l|>|\partial\varepsilon_k(s'_h,s_l)/\partial s_l|$ requires: $(a+e_1 s_h'^{\gamma})(a-e_k s_l^{\gamma})>(a-e_k s_h'^{\gamma})(a+e_1 s_l^{\gamma})$. Multiplying, rearranging and cancelling of identical terms yields: $(e_1+e_2)s_h'^{\gamma}>(e_1+e_2)s_l^{\gamma}$. For $s_l<s'_h$, this condition is always satisfied.

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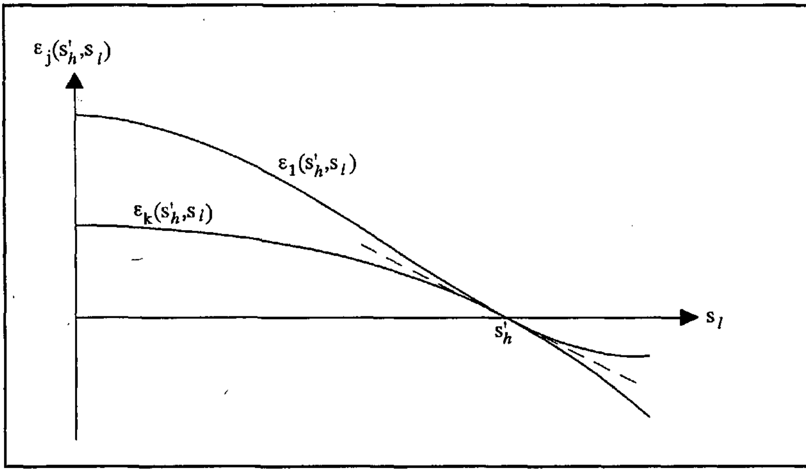
Figure A.1. Relationship between $\varepsilon_1(s'_h,s_l)$ and $\varepsilon_k(s'_h,s_l)$.



Step 3. Inserting $s_l=s'_h$ into (A.2) and (A.3) respectively, yields $\varepsilon_1(s_l=s'_h)=\varepsilon_k(s_l=s'_h)=0$ and $\partial\varepsilon_1(s'_h,s_l)/\partial s_l=\partial\varepsilon_k(s'_h,s_l)/\partial s_l$. Hence, $\varepsilon_1(s'_h,s_l)$ and $\varepsilon_k(s'_h,s_l)$ have a common tangent in $\varepsilon_1(s_l=s'_h)=\varepsilon_k(s_l=s'_h)=0$.

Step 4. Differentiating $\partial\varepsilon_k(s'_h,s_l)/\partial s_l$ with respect to s_l yields the second derivative

(A.4) $$\partial^2\varepsilon_k(s'_h,s_l)/\partial s_l^{\,2}=-\omega\left(a-e_k s_h'^{\gamma}\right)\left[(2\gamma-1)e_1 s_l^{\gamma}+(\gamma-1)a\right],$$

with $\omega:=\left(4\gamma^2 e_1 e_k s_h'^{\gamma-1} s_l^{\gamma-2}\right)(9b)^{-2}$. Due to $\omega>0$, $\gamma\geq 1$ and $a>e_k s_h'^{\gamma}$, $\partial^2\varepsilon_k(s'_h,s_l)/\partial s_l^2$ is negative, i.e. $\varepsilon_k(s'_h,s_l)$ is concave.

Step 5. Differentiating $\partial\varepsilon_1(s'_h,s_l)/\partial s_l$ with respect to s_l yields the second derivative

(A.5) $$\partial^2\varepsilon_1(s'_h,s_l)/\partial s_l^{\,2}=\omega\left(a+e_1 s_h'^{\gamma}\right)\left[(2\gamma-1)e_1 s_l^{\gamma}-(\gamma-1)a\right],$$

where ω is defined as above. The sign of $\partial^2\varepsilon_1(s'_h,s_l)/\partial s_l^2$ thus depends on the magnitude of s_l. Defining $\hat{s}_l:=[a(\gamma-1)/e_k(2\gamma-1)]^{1/\gamma}$, equation (A.5) implies that $\varepsilon_1(s'_h,s_l)$ is concave for $s_l<\hat{s}_l$ and convex for $s_l>\hat{s}_l$.

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