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THE POLITICAL ECONOMY OF DECLINING INDUSTRIES: SENESCENT INDUSTRY COLLAPSE REVISITED

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ABSTRACT

One of the most robust empirical regularities in the political economy of trade is the persistence of protection. This paper explains persistent protection in terms of the interaction between industry adjustment, lobbying, and the political response. Faced with a trade shock, owners of industry-specific factors can undertake costly adjustment, or they can lobby politicians for protection and thereby mitigate the need for adjustment. The choice depends on the returns from adjusting relative to lobbying. By introducing an explicit lobbying process, it can be shown that the level of tariffs is an increasing function of past tariffs. Since current adjustment diminishes future lobbying intensity, and protection reduces adjustment, current protection raises future protection. This simple lobbying feedback effect has an important dynamic resource allocation effect: declining industries contract more slowly over time and never fully adjust. In addition, the model makes clear that the type of collapse predicted by Cassing and Hillman (1986) is only possible under special conditions, such as a fixed cost to lobbying. The paper also considers the symmetric case of lobbying in growing industries.

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I. INTRODUCTION

One of the most robust and least discussed empirical regularities in the political economy of trade is the persistence of protection. Empirical research by a number of authors suggests that past levels of protection are significant in explaining current protection levels in an industry. For instance, in their study of the pattern of protection that emerged in the U.S. following the Kennedy Round of the GATT, Marvel and Ray (1983) found that an industry was more successful in resisting liberalization the higher was its level of protection preceding the liberalization, after controlling for industry growth rates, industry concentration, comparative advantage, and buyer concentration. Similarly, in studies of both the Kennedy and Tokyo Rounds, Baldwin (1985) found that industries received more post-liberalization protection the greater were pre-liberalization levels of protection, even after controlling for labor force characteristics, growth rates, and import penetration ratios. In empirical tests explaining corporations' positions on 6 trade initiatives during the 1970s, Pugel and Walters (1985) found that the demand for protectionism was strongly increasing in the industry's initial tariff level, controlling for import penetration and variables reflecting exporting strength.

This paper offers an explanation for the persistence of protection in terms of the interaction between industry adjustment, lobbying, and protection. The story is simple, but the results are quite striking. Faced with a trade shock, owners of industry-specific capital can respond by undertaking costly adjustment. Alternatively, they can lobby politicians for trade protection, and thereby mitigate the need for adjustment. The choice between the two will reflect the relative profitability of adjusting versus lobbying. In equilibrium, the level of protection will depend on the intensity of lobbying and on the value politicians place on lobbying revenues relative to the welfare cost of the intervention, and will in turn affect firms' marginal adjustment decisions. By introducing an explicit lobbying process similar to Grossman and Helpman

(1992), it can be shown that the level of tariffs is an increasing function of past tariffs. This relationship works indirectly through the adjustment process: since current adjustment diminishes future lobbying effectiveness, and protection reduces current adjustment, current protection raises future protection. This simple lobbying feedback effect has an important dynamic resource allocation effect: declining industries contract more slowly over time and contract less than they would in the absence of protection.

Several papers have studied protection and lobbying in declining industries. Hillman (1982) examines political-support protectionist responses to declining industries by adapting the regulatory capture framework of Stigler (1971) and Peltzman (1976) to an international trade context. He shows that the derived protection does not fully compensate specific factors in the import-competing industry for the adverse terms-of-trade shock. Long and Vousden (1991) extend the analysis to a general equilibrium Ricardo-Viner framework, and discuss how this partial compensation result is affected by the degree of risk aversion of the specific factor owners and by the way tariff revenues are redistributed. Both papers share the feature that the analysis is static and the political support function is specified exogenously as a black box.

Dynamic aspects of protectionist policies have also been investigated. Several authors have analyzed circumstances under which the adjustment path under protection is socially suboptimal in the absence of lobbying.[1] In contrast, Cassing and Hillman's (1986) analysis of senescent industry collapse explicitly considers the effect of lobbying on industry dynamics. The Cassing, Hillman model differs from the one presented below in two important respects. First, the Cassing, Hillman analysis hinges on an ad hoc tariff response function, which is increasing in the level of labor in an industry, whereas we derive it

[1] See Matsuyama (1987), Tornell (1991), and Brainard (1993). These results generally hinge on a dynamic inconsistency problem.

explicitly from interaction between a politician and specific factor owners in an industry. Secondly, the Cassing, Hillman model predicts that initially resources will shift gradually out of an industry in response to an adverse trade shock, up to some point at which protection is abruptly terminated, and the industry collapses.[2] This discontinuous adjustment behavior is attributable to an inflection point in the tariff response function, which is ad hoc. In contrast, the model presented below predicts a smooth path of decline in response to an adverse shock. In an extension, we show that results similar to those of Cassing and Hillman require an additional assumption, such as a per period fixed cost to lobbying.

The model is designed so that it can be applied symmetrically to the case of a growing industry. We examine this case in another extension to make the point that the disproportionate share of protection afforded to mature industries in countries such as the US is better explained by a bias in the political process than by pure economic differences. We also discuss the implications for general equilibrium.

The paper proceeds as follows. Section II establishes the central results in a two-period model of the interaction between a trade-impacted industry and a politician. Section III extends this model to a discrete time, infinite horizon framework by simplifying the interaction between the industry and the politician. Section IV extends the model to consider industry collapse. Section V considers growing industries and the implications for general equilibrium. Section VI concludes.

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2 Lawrence and Lawrence (1987) also develop a model in which labor adjustment in a declining industry is discontinuous. However, there is no political intervention in their model. The discontinuity is attributable to the combination of lumpy capacity reduction with monopoly behavior on the part of labor.

II. TWO-PERIOD MODEL

We start with an industry that is a price taker on international markets. There is a specific factor in the industry, which is fixed, and a variable factor. The variable factor is supplied competitively, and any rents accrue to the owners of the specific factor. At the beginning of each period $t \in \{1,2\}$, there is a capacity level in the industry, y_t. Each period, the specific factor owners choose to adjust capacity by some amount x_t (where $x>0$ implies contraction). Production takes place after the adjustment has occurred. Given the fixed specific factor input, output is assumed equal to the net level of capacity, $q_t = y_t - x_t$, which is also just equal to the capacity level at the beginning of the next period, y_{t+1}.

For clarity, we focus on a case with linear demand and quadratic costs. Brainard, Verdier (1993) shows that similar results obtain in the general case under reasonable restrictions. There is a cost of adjustment, ϕ, which is a quadratic, increasing function of the amount of adjustment: $\phi(x_t)=x_t^2/2$. The cost of production is also assumed quadratic and increasing in output: $C(q_t)=q_t^2/2$.

Domestic demand is a linear, decreasing function of the domestic price p_t: $D(p_t)=\sigma-p_t$. In the absence of intervention, the domestic price is just equal to the exogenously given world price, $p_{w,t}$. We will assume that the international price is constant over time, with the exception of a discrete jump at time 0. Prior to that time, both the international price and the domestic price are constant at p_0, which is consistent with an equilibrium output level, y_w^0. The output level is chosen such that the marginal cost of production equals the price: $C'(y_w^0)=p_0$, which implies $y_w^0=p_0$. At time 0, a permanent shock in the international market causes a decline in the world price to $p_w<p_0$. Thus, the capacity at the outset of period 1, $y_1=y_w^0$, exceeds the new long run equilibrium output level, and the industry must contract in order to bring the marginal costs of production down to the new international price.

Adjustment:

In the absence of lobbying, the industry does not receive any protection, since there are no market imperfections. In this case, its adjustment program is defined as :

(1)
$$MAX_{x_1,\,x_2}\ \pi(p_w,y_1,x_1)\ +\ \rho\ \pi(p_w,y_2,x_2) \qquad with\ \ y_2=y_1-x_1$$

where ρ is the discount factor of the industry, and profits in period t are defined:

$$\pi(p_t,y_t,x_t)\ =\ p_t(y_t-x_t)-C(y_t-x_t)-\phi(x_t)$$

The first order conditions are:

(2)
$$-p_w+C'(y_1-x_1)+\rho[-p_w+C'(y_1-x_1-x_2)]=\phi'(x_1)$$

(3)
$$-p_w+C'(y_1-x_1-x_2)=\phi'(x_2)$$

In each period the industry trades off the marginal return to adjustment against the marginal cost. Solving the two first order conditions yields the optimal adjustment levels:

(4)
$$x_1=(p_0-p_w)\frac{(1+\phi(1+\rho))}{(1+\phi)^2+\rho\phi}$$
$$x_2=(p_0-p_w)\frac{\phi}{(1+\phi)^2+\rho\phi}$$

First period adjustment, x_1, is decreasing in the new international price level, p_w, and increasing in the initial capacity, y_1 (which is equal to the initial international price, p_0), with $0<\partial x_1/\partial y_1<1$, which implies that second period capacity, y_2, is increasing in y_1. Second period adjustment, x_2, is a decreasing function of y_2, and therefore increasing in the initial capacity, y_1. There is a negative direct effect of the increase in the world price p_w on x_2^*, which outweighs the positive indirect effect through the decline in x_1, so that a smaller price shock results in lower adjustment in period two: $\partial x_2^*/\partial p_w< 0$. Thus, adjustment in each period is increasing in the size of the price shock.

Lobbying:

Next we assume the industry has the option of lobbying to influence the domestic price. The domestic price is the product of an endogenously determined ad valorem tariff, θ_t, and the exogenous world price: $p_t=(1+\theta_t)p_{w,t}$. Following Helpman and Grossman (1992), we model the lobbying process as a contribution game where, in each period, the industry can influence the tariff level by offering a schedule of contributions to the incumbent politician as a function of the tariff, or equivalently, of the two prices, $F(p_t,p_w)$. Given world price, p_w, and adjustment, x_t, profits in period t are:

(5) $$\pi(p_t,y_t,x_t) = p_t(y_t-x_t)-C(y_t-x_t)-\phi(x_t)-F_t(p_t,p_w)$$

The policymaker values both social welfare, W, and lobbying contributions in different degrees. We assume that the utility function in period t is linear in both elements:

(6) $$G(p_t,y_t,x_t) = \beta W(p_t,y_t,x_t)+(1-\beta)F_t(p_t,p_w)$$

where the weight on welfare, β, lies between 1/2 and 1. Welfare in period t is the sum of consumer surplus, industry profits and tariff revenue:

$$W(p_t,y_t,x_t) = \int_{p_t}^{\infty} D(u)du + p_t(y_t-x_t) - C(y_t-x_t)-\phi(x_t) + (p_t-p_w)M(y_t,p_t,x_t)$$

where $M(y_t,p_t)=D(p_t)-(y_t-x_t)$ is the import demand function. This objective function is the partial equilibrium, dynamic analogue of that developed in Grossman, Helpman.[3] The most straightforward interpretation is that the politician values contributions for their consumption value. The objective function could alternatively be interpreted as maximizing the probability of reelection at the end of the adjustment period, where the probability is linearly

[3] The welfare weight parameter, a, in Grossman, Helpman is just equal to $\beta/(1-\beta)$ here.

increasing in contributions and welfare.[4] In the interests of simplicity, it ignores a host of interesting features of political interaction, especially competition between political parties. But, as Grossman, Helpman point out, evidence that lobby groups disproportionately make contributions to incumbents and frequently contribute to candidates after they have won suggests this simplification has some empirical credence.

i. Adjustment Follows Tariff Choice

The timing of the game is as follows:

period 1			period 2		
Industry	Government	Industry	Industry	Government	Industry
F_1	p_1	x_1	F_2	p_2	x_2

In each of the two periods, the industry first chooses its contribution function, F_t, the politician then chooses the domestic price, p_t, given the contribution schedule, and finally the industry chooses the level of adjustment, x_t.[5]

The second period lobbying game:

Solving backwards, the industry chooses x_2 to maximize $\pi(p_2,y_2,x_2)$, yielding the first order condition in (3), which gives x_2 as a function of capacity, y_2, and domestic price, p_2:

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[4] If instead the politician were maximizing reelection probabilities each period, it would require linking future payoffs to current contributions via the probability of current period reelection. This would considerably complicate the analysis.

[5] Qualitatively similar results obtain if instead the government is assumed to choose a price schedule as a function of the contribution, and the firm then chooses its contribution and employment level simultaneously.

(7) $$x_2^*(y_2,p_2) = \frac{y_2-p_2}{1+\phi}$$

Second period adjustment is a decreasing function of the second period tariff (reflected in the domestic price level), and of first period adjustment, since $y_2 = y_1 - x_1$. Plugging the optimal adjustment from (7) into the profit function in (5), yields the indirect profit function, $\pi^*(p_2,y_2) = \pi(p_2,y_2,x_2^*)$, which is decreasing in the capacity, y_2, and increasing in the domestic price, p_2.

Fully anticipating the industry's output response, the politician chooses the tariff to maximize $G(p_2,y_2,x_2^*)$. The first order condition yields an expression relating the marginal industry contribution to the marginal deadweight loss of the tariff weighted by the politician's relative valuation of welfare, $\beta/(1-\beta)$:

(8) $$\frac{\beta}{1-\beta}(p_2-p_w)\left[D'(p_2)+\frac{\partial x_2^*}{\partial p_2}\right] + \frac{dF_2(p_2,p_w)}{dp_2} = 0$$

In order to induce the politician to choose the domestic price level, p_2, the trade-impacted industry has to propose a contribution schedule that exactly compensates on the margin the associated social welfare loss, weighted by the politician's preference for contributions. The level of tariff protection increases in the marginal contribution and decreases in the weight the politician assigns to welfare. When the politician values only social welfare ($\beta=1$), the tariff is 0.

The industry chooses its contribution (or equivalently the domestic price) in period 2 so that the marginal cost of lobbying just equals the marginal benefit to the industry from increased protection:

(9) $$(y_2-x_2^*) = \frac{dF_2(p_2,p_w,y_2)}{dp_2}$$

This is the condition that Grossman, Helpman term "local truthfulness." In equilibrium, the industry chooses a contribution schedule that satisfies conditions (8) and (9) and leaves the politician just indifferent between free trade and implementing the desired tariff and receiving the associated contribution. The equilibrium tariff level can be restated in the familiar Ramsey form (Grossman, Helpman):[6]

$$(10) \qquad \frac{(p_2-p_w)}{p_w} = \frac{(1-\beta)}{\beta}\frac{(y_2-x_2^*)}{M_2(p_2)}\frac{1}{\epsilon_{M_2}(p_2)}$$

where $M_2(p_2)$ is the import demand in period 2 and $\epsilon_M(p)$ is the elasticity of import demand with respect to the domestic price.

Combining the conditions for the equilibrium contribution and adjustment yields the equilibrium price level in period two, p_2^*, as a function of the initial capacity in that period and the world price:

$$(11) \qquad p_2^*(y_2,p_w) = \frac{\phi(1-\beta)y_2+\beta(1+\phi)p_w}{\beta(2+\phi)-1}$$

Second period protection is an increasing function of the capacity at the beginning of the period and therefore a decreasing function of the adjustment undertaken in the previous period.

The first period lobbying game:

Continuing backwards, the industry's first period adjustment level is chosen taking into account its effect on the level of protection and adjustment in period two. The maximization program for the industry can be written as:

$$(12) \qquad MAX_{x_1}\ p_1(y_1-x_1) - C(y_1-x_1) - \phi(x_1) + \rho\pi^*(p_2^*(y_1-x_1),y_1-x_1,x_2^*)$$

Using the envelope theorem for the second period profit function and equation (7), the first order condition for x_1 can be written as:

[6] The equilibrium tariff can alternatively be derived by restricting consideration to differentiable contribution schedules and assuming that the industry provides no contribution if there is no protection: $F_i(p_w,p_w)=0$. This assumption can be justified here because there are no competing lobbies, whereas in the Grossman, Helpman framework, each industry's contribution includes a constant that is equal to the difference between its return when it lobbies and when it does not, given the equilibrium contributions of competing lobbies.

(13) $$-p_1 + C'(y_1 - x_1) + \rho\left[\phi'[x_2^*(y_1 - x_1)] + \frac{\partial F_2}{\partial y_2}\right] = \phi'(x_1)$$

The first two terms represent the marginal gain from adjustment in period 1, while the third term is the marginal adjustment cost saved in period 2 due to adjustment in period 1. The last term represents the strategic impact of adjustment in period 1 on the lobbying contribution in period 2. In the linear quadratic case here, it is equal to zero. At the equilibrium, the marginal direct and indirect returns from adjustment are balanced against the marginal cost of adjustment in the current period. This defines the optimal adjustment level, x_1^*, as a function of the initial capacity and the domestic price, p_1:

(14) $$x_1^*(y_1,p_1) = \frac{(\beta(2+\phi)-1+\rho\phi(2\beta-1))y_1-(\beta(2+\phi)-1)p_1-\rho\beta\phi p_w}{(1+\phi)(\beta(2+\phi)-1)+\rho\phi(2\beta-1)}$$

First period adjustment is decreasing in the domestic and international price levels and increasing in the initial capacity level, with $0 < \partial x_1^*/\partial y_1 < 1$.

Combining equation (14) with the equilibrium second period domestic price level in equation (11) establishes that the second period tariff is an increasing function of the first period tariff. The intuition is straightforward: the higher is the domestic price in the first period the less the industry adjusts, and the lower is first period adjustment the more the industry lobbies in period two.

Continuing farther backwards, the government chooses the domestic price, p_1, anticipating its effect on the industry's subsequent adjustment and lobbying in period 2, and taking as given the contribution schedule proposed in that period. Assuming the policymaker has the same discount rate as that of the industry, the politician's optimization problem is:

(15) $$Max_{p_1}\ G(p_1,y_1,x_1^*)+\rho G(p_2^*(y_1-x_1^*);y_1-x_1^*,x_2^*)$$

Using the envelope theorem with respect to the optimal second period price and adjustment yields the first order condition for the politician:

$$\frac{dF_1(p_1,p_w)}{dp_1} = -\frac{\beta}{(1-\beta)}\left[(p_1-p_w)\left(D'(p_1)+\frac{\partial x_1^*}{\partial p_1}\right)+\rho(p_2^*-p_w)\left(1-\frac{\partial x_2^*}{\partial y_2}\right)\frac{\partial x_1^*}{\partial p_1}\right]+\rho\frac{\partial F_2}{\partial y_2}\left(\frac{\partial x}{\partial p}\right. \tag{16}$$

In equilibrium, the lobbying contribution in period 1 must balance three terms at the margin. The first term in equation (16) is the familiar static deadweight loss. The second term reflects the loss of tariff revenue in period 2 due to the increase in production implied by reduced adjustment in period 1. The third term is the strategic impact of period 1 protection on the lobbying contribution in period 2, which is 0 in the linear-quadratic case here.

The industry chooses the optimal tariff taking the politician's anticipated tariff response as a constraint. Using the envelope theorem, the first order condition is:

$$y_1 - x_1^*(p_1,y_1) = \frac{dF_1(p_1,p_w,y_1)}{dp_1} \tag{17}$$

which defines the equilibrium first period protection level as a function of the initial capacity, y_1. Again, the industry chooses its contribution to satisfy the two marginal conditions and leave the politician indifferent between protection with the contribution and free trade. Without solving explicitly, these conditions yield an expression for $\partial p_1^*/\partial y_1$:

$$\frac{\partial p_1^*}{\partial y_1} = \left[\left(1-\frac{\partial x_1^*}{\partial y_1}\right)\frac{(1-\beta)}{\beta}+\rho\frac{\partial p_2^*}{\partial y_1}\left(1-\frac{\partial x_2^*}{\partial y_2^*}\right)\frac{\partial x_1^*}{\partial p_1}\right]\left(1-\frac{\partial x_1^*}{\partial p_1}\right)^{-1} \tag{18}$$

The first term, which represents the direct effect of the initial level of capacity on protection, is positive: the higher is the initial capacity level, the higher is output in period 1, and the higher is the tariff, weighting by the relative valuation of contributions. The second term, which represents the indirect effect on tariff revenues in period two, is negative but smaller than the first term. Thus, $\partial p_1/\partial y_1$ is positive, and protection in period 1 is increasing in the initial capacity. Moreover, the level of protection in both periods is greater the larger is the initial price shock (recalling that $y_1 = p_0$).

ii. Adjustment Precedes Tariff Choice

In order to clarify the connection between the results from the two-period game and the infinite horizon framework presented in the next section, we first show that similar results obtain when the timing structure of the stage game is simplified in the two-period framework. We simplify by assuming that the industry chooses its adjustment level and contribution schedule simultaneously each period, followed by the politician's choice of tariff level.

Starting in period two and solving backwards, the politician chooses the tariff to maximize $G(p_2;y_2,x_2)$ given the industry's prior choice of y_2 and x_2. The first order condition yields an expression equalizing the marginal industry contribution to the marginal welfare cost of an increase in the domestic price level weighted by the relative valuation of welfare:

$$(8') \qquad -\frac{\beta}{1-\beta}(p_t - p_w)D'(p_t) = \frac{dF_t(p_t,p_w)}{dp_t}$$

for $t=2$.

The industry chooses its contribution and adjustment level to maximize $\pi(p_2,y_2,x_2)$ anticipating the politician's tariff response. The first order condition with respect to the adjustment level is identical to equation (3) and the first order condition with respect to the contribution is identical to equation (9). The industry chooses the contribution schedule that satisfies conditions (8') and (9) in equilibrium and leaves the politician just indifferent between protection with the contribution and free trade. Together, these 3 conditions yield the optimal period two domestic price and adjustment levels:

$$(19) \qquad x_2^* = \frac{(1-a)y_2 - p_w}{1+\phi-a}$$

$$(20) \qquad p_2^* = \frac{\phi a y_2 + (1+\phi)p_w}{1+\phi-a}$$

where $a = (1-\beta)/\beta$ is the politician's relative valuation of contributions. The price is increasing in the second period capacity level and the politician's relative valuation of contributions and increasing in the international price. In contrast, the adjustment level is decreasing in the politician's relative valuation of contributions and international price and increasing in the capacity level.

Continuing back to period 1, the politician chooses the domestic price level anticipating its effect on future decisions, given first period adjustment and the industry's contribution schedule. With the simplified timing structure, the politician's first period first order condition is identical to equation (8') for t=1.

The industry chooses its adjustment and contribution in period 1 anticipating the politician's optimal choice of tariff and the effect on second period profits through the effect on capacity. Again using the envelope theorem, the first order condition for adjustment is the same as equation (13), and the first order condition for the contribution is the same as equation (17). The industry chooses its contribution to satisfy both marginal conditions and leave the politician indifferent about intervening. Together, these conditions establish the equilibrium first period price and adjustment levels:

$$x_1^* = \frac{((1-a)y_1 - p_w)(1+\phi-a+\rho\phi)}{(1+\phi-a)^2+\rho\phi(1-a)} \tag{21}$$

$$p_1^* = a(y_1 - x_1^*) + p_w \tag{22}$$

First period adjustment is increasing in the initial capacity and decreasing in the politician's relative valuation of contributions and the international price. The domestic price is increasing in the initial capacity and the politician's relative valuation of contributions and the international price.

Together, equations (19) through (22) establish that the basic result remains robust with the simpler timing structure: the level of protection in the second period is a decreasing function of the first period adjustment, which in turn is a decreasing function of the first period protection. And adjustment in both periods is decreasing in the level of anticipated protection.

III. INFINITE HORIZON MODEL

We now extend the model to the infinite horizon case. In order to derive an explicit path of adjustment for output and domestic prices over an infinite horizon, we maintain the simplified timing structure of the stage game. Each period, the industry is assumed to choose its adjustment level and its contribution schedule simultaneously, after which the politician chooses a tariff level to maximize utility. This timing assumption assigns greater commitment power to the industry's action each period compared to the three-move structure, but this is offset by the alternating sequence of moves in an infinite horizon context.

Both the industry and the politician are assumed to employ Markov strategies. The state variable is the capacity, whose evolution is described by the simple equation:

$$y_{t+1} = y_t - x_t \tag{23}$$

Then the politician's value function is:

$$V_g(y_t) = Max_{p_t}\ [\beta W(p_t, y_t) + (1-\beta)F_t(p_t, p_w) + \delta V_g(y_{t+1})] \tag{24}$$

Given the relationship between the domestic price and the contribution level embodied in the politician's first order conditions, the industry maximizes its value function by its choice of contribution and adjustment levels:

$$V_f(y_t) = Max_{p_t x_t}\ [p_t(y_t - x_t) - \frac{(y_t - x_t)^2}{2} - \frac{\phi x_t^2}{2} - F_t(p_t, p_w) + \rho V_f(y_{t+1})] \tag{25}$$

With this timing structure and Markov strategies, the politician's protection decision affects only the contemporaneous levels of the contribution and adjustment. Therefore, the politician's problem can be simplified to a static maximization problem. Choosing the optimal level of protection as a function of contributions yields the same condition on the relationship between the marginal contribution and the tariff level as in equation (8').

Faced with this tariff response function, the industry's problem simplifies considerably, permitting the first order conditions to be expressed as a second order difference equation. Local truthfulness of the contribution schedule yields the relationship between the marginal contribution and the industry's marginal profits in equation (9) (with t replacing 2 in the subscripts). Equations (8') and (9) together with the condition that the industry chooses the contribution to leave the politician indifferent about intervening yields:

$$(26) \qquad y_{t+1} = \frac{(p_t - p_w)}{a}$$

where y_t-y_{t+1} is substituted for x_t. Differentiating with respect to the output level yields:

$$(27) \qquad p_t = -\rho\phi y_{t+2} + (1+\phi(1+\rho))y_{t+1} - \phi y_t$$

Combining (26) and (27) and using the initial condition that the capacity at time 0 is equal to the initial price level p_0 (and setting the coefficient on the larger root to 0) yields the industry's optimal adjustment path equation:

$$(28) \qquad y_t = \left(p_0 - \frac{p_w}{(1-a)}\right) b(a)^t + \frac{p_w}{(1-a)}$$

where the root is defined:

$$(29) \qquad b(a) = \frac{1-a+\phi(1+\rho)-\sqrt{(1-a)^2+2(1-a)\phi(1+\rho)-4\rho\phi^2+\phi^2(1+\rho)^2}}{2\phi\rho}$$

and $0<b(a)<1$ for the restrictions on β adopted above, and $b'(a)>0$.

This path can be contrasted with the adjustment path in the free market equilibrium, which is obtained by setting the politician's weight on welfare to 1 ($a=0$):

$$(30) \qquad y_t = (p_0 - p_w) b(0)^t + p_w$$

Comparing the two expressions reveals three channels through which lobbying affects the adjustment path. The equilibrium capacity is higher each period because lobbying reduces the rate of adjustment and reduces the cumulative amount of adjustment that takes place, and these two effects more than offset the decrease in the coefficient, $p_0 - p_w/(1-a)$, due to the reduction in the price shock. The rate of adjustment is slower, and the long run equilibrium level of capacity is higher, the greater is the politician's preference for contributions relative to welfare. With lobbying, output is adjusted downward smoothly, at a decreasing pace, eventually converging to a level that is permanently above the efficient level. The two paths of adjustment are compared in Figure 1.

The path of the associated equilibrium tariff can be derived by combining the industry's first order conditions with the adjustment path of output:

(31)
$$\theta_t = b(a)^t \frac{p_0}{p_w} a + (1 - b(a)^t) \frac{a}{1-a}$$

The level of protection declines smoothly and gradually with output over time, reflecting the effect of past protection through the current capacity. Further, the tariff is higher at each point of time, the larger is the initial adverse shock or shift of comparative advantage (measured by p_0/p_w). This is closely related to "the compensation effect" of Magee and Young (1989). The larger the initial shock, the more the industry must adjust in order to adapt to the new international environment, and the larger are the incentives to lobby for protection to mitigate the need for costly adjustment.

IV. SENESCENT INDUSTRY COLLAPSE

Our result differs markedly from that of Cassing, Hillman, who find that the industry declines smoothly up to some point, after which it suddenly loses protection and collapses. This result is attributable to the shape of their tariff response function, which switches from convex to concave at some threshold level of capacity. By making the tariff formation process explicit, the framework above makes clear that some kind of discontinuity would be required in the industry's lobbying activities to yield a point of collapse. In particular, if participation in the lobbying process each period required the payment of a fixed cost, C, in addition to the variable contribution, then the industry would lobby only as long as the intertemporal return to lobbying offsets the fixed cost. Such a fixed cost might be associated with operating an information network, maintaining political connections, or paying lobbyist's fees.

Recall that with a zero fixed cost, the industry always lobbies, and adjusts gradually to a level of capacity, $p_w/(1\text{-}a)$, above the free market level, p_w. Intuitively, the effect of introducing a fixed per period cost is fairly clear. If the fixed cost is below the per period return to lobbying when adjustment has reached its steady state, $C < ap_w^2/2$, then the industry never finds it optimal to stop lobbying and receives protection permanently. There is a smooth adjustment process, which is identical to that in equation (28). If the fixed cost exceeds the difference between the return to lobbying and the free market return at time 0, when output is at its maximum relative to the steady state value, the industry never lobbies and simply adjusts according to (30). For a fixed cost in an intermediate range between these two levels, the industry lobbies and receives protection for some finite number of periods, $\tau(y_0)$. Up to time $\tau(y_0)$, the industry lobbies and contracts gradually, cushioned by the resulting protection. The rate of contraction on this interval lies between that under permanent protection and the free market rate. At time $\tau(.)$, it is no longer worth paying the fixed cost, so the industry stops lobbying and loses its political influence. Domestic protection collapses to zero, and adjustment accelerates in a discontinuous manner.

The appendix proves these results and specifies the relationship between the time, τ, the fixed cost, C, and the other parameters of the model. The proof proceeds by defining the value function for a single period of lobbying followed by no lobbying, and then solves forward recursively to determine the optimal number of periods of lobbying before the switch to no lobbying. This value function for optimal temporary lobbying is compared to the value functions for permanent lobbying and for unprotected adjustment, and the resulting inequalities define the ranges for the fixed cost relative to the intertemporal return from lobbying.

V. GROWING INDUSTRIES AND GENERAL EQUILIBRIUM

Growing Industries

The case of growing industries may be accommodated quite simply in the above framework, with rather startling results. Start by assuming there is no fixed cost. Suppose that there is a permanent price shock at time t, such that p_0 rises to some level, p_w. In the free market economy, the industry will want to raise capacity each period, to adjust to the steady state level $y_w = p_w > y_0$, so that adjustment will be positive in equilibrium. The analysis of lobbying in a growing industry is exactly symmetric to the case of decline, as are the maximizing levels of contributions and adjustment each period. Proceeding through the same steps as for the declining industry in the infinite horizon framework yields an expression for the equilibrium capacity in period t:

(32)
$$y_t = \frac{p_w}{(1-a)} - \left(\frac{p_w}{(1-a)} - p_0\right) b(a)^t$$

where the characteristic root is defined as in equation (29). When it lobbies, a growing industry grows more rapidly than it would in the free market, at a rate increasing in the size of the price shock, and the steady state level of output exceeds that in the free market by an amount that increases with the politician's preference for contributions.

This suggests that the empirical evidence that declining industries receive a disproportionate share of protection in countries such as the US would be better explained by a bias in the political process than by pure economic differences. There are a variety of reasons why the political process may be biased against growing industries. First, there may be important differences in the cost of lobby formation for fledgling as opposed to mature industries. In the model above, we simply assume that an industry lobbies whenever the intertemporal return is positive, thereby ignoring the critical issue of lobby formation. However, research in political science suggests that industries are more likely to overcome the free rider problems of lobby formation when they have large committed resources and established unions. In addition, growing industries are characterized by rapidly changing market structures and a high likelihood of future entry, while declining industries are more likely to have stable market structures with a reduced threat of domestic entry. The greater risk that future rents will be dissipated with entry may make lobby formation more difficult in growing industries than in declining industries with clearly identified players and more predictable rents.

Secondly, in the presence of imperfect capital markets[7], liquidity constraints on lobbying activities may be more binding in a growing industry than in a declining industry. This would be the case if incumbent domestic firms in mature industries have more accumulated cash reserves from past retained profits relative to investment opportunities than do firms in emerging industries. To illustrate the effect of a liquidity constraint, assume that firms must finance both investment and contributions from current profits. The industry's maximization program is modified to take into account the liquidity constraint as follows:

$$V_t(y_t,\lambda_t) = Max_{p_t,y_{t+1}} \left(p_t y_{t+1} - \frac{y_{t+1}^2}{2} - \frac{\phi(y_{t+1}-y_t)^2}{2} - \frac{(p_t-p_w)^2}{2a} \right)(1+\lambda_t) + V_t(y_{t+1},\lambda_{t+1}) \tag{6}$$

where λ_t is the multiplier on the liquidity constraint. Since the unconstrained equilibrium profit level rises monotonically over time, the constraint must bind

[7] Imperfect capital markets may exist because either it is not possible to borrow to finance lobbying, or investors are less optimistic about an industry's future growth path than are industry participants due to asymmetric information.

initially and over a continuous interval, if it binds at all. When the constraint binds, it affects the equilibrium output only through the characteristic root:

$$b(a,L_t) = \frac{1-a+\phi(1+\rho L_t)-\sqrt{[(1-a)+\phi(1+\rho L_t)]^2-4\phi^2\rho L_t}}{2\phi\rho L_t} \tag{34}$$
$$\textit{where } L_t = \frac{(1+\lambda_{t+1})}{(1+\lambda_t)}$$

Thus, a binding constraint lowers the industry growth rate relative to the unconstrained lobbying path.[8] However, the growth rate remains above the free market rate, and the long run equilibrium value is the same as that for unconstrained lobbying. The equilibrium adjustment paths for the unconstrained lobbying equilibrium, constrained lobbying equilibrium, and unconstrained free market equilibrium are compared in Figure 2.

In addition, a fixed cost in the lobbying process might create a bias against growing industries. Suppose, as above, that the fixed cost does not depend on the size of the industry. If an industry ever starts to lobby, it will not subsequently stop lobbying, since the return to lobbying never decreases in a growing industry. Thus, an industry chooses how many periods to wait before it starts lobbying. If the per period return to lobbying exceeds the fixed cost in the first period, it lobbies permanently, and conversely if the fixed cost exceeds the return to lobbying at the steady-state level of output under lobbying, then the industry never starts lobbying. If the fixed costs lies in some intermediate range, then the industry waits for some optimal number of periods until it is large enough that the return to lobbying exceeds the fixed cost, and begins lobbying.

---

[8] It is not possible to solve for L_t explicitly. However, by combining (34) with the liquidity constraint it can be shown that b is declining in L and that L is rising over time under sensible conditions, such that b is decreasing over time.

Implications for General Equilibrium

These results ignore potential spillover effects of lobbying across sectors, which is a central consideration in understanding the effect of lobbying on dynamic resource allocation. In a general competition for protection, there are a variety of channels whereby the equilibrium pattern of protection might result in a diversion of resources away from infant industries toward industries with declining competitiveness. The results derived by Grossman and Helpman (1992) in a static general equilibrium framework, where protection spills over between interest groups through consumption, suggest that mature sectors would gain protection at the expense of infant industries in a competition for protection if the infants were less well organized than mature industries for any of the reasons cited above or if the infants initially were smaller. Similarly, in a model where there is a limited supply of a common factor of production, or the import-competing sector produces an input used by the exporting sector, the equilibrium pattern of protection might result in resources being directed away from the growing industries to mature industries, distorting adjustment in both directions. If the distortions were sufficiently great, growing industries would grow more slowly in a lobbying equilibrium than in the free market equilibrium.

VI. CONCLUSION

Motivated by the strong empirical regularity that the best predictor of future protection is past protection, this paper has analyzed the adjustment path in declining industries under endogenous protection. By introducing an explicit political objective function similar to that developed in a static framework by Grossman and Helpman into a dynamic model with convex adjustment costs, the paper shows that the level of tariffs is an increasing function of past tariffs. In this model, industry adjustment and lobbying are substitutes: the more an industry lobbies, the greater the protection it receives and the less it adjusts, and the less the industry adjusts the more effective it is in lobbying next period.

Lobbying is an increasing function of the initial price shock, or equivalently of the gap between the initial level of capacity and the long run equilibrium level.

The paper finds that in the absence of nonconvexities in the lobbying process, the paths of lobbying and adjustment are smooth. The industry contracts output gradually over time to a level that is permanently above the free market level by an amount that increases in the value the politician places on lobbying contributions relative to welfare. This result contrasts sharply with the Cassing and Hillman finding that there is a point of collapse, which corresponds to an inflection point in an ad hoc tariff response function. Here, we derive a similar collapse in the path of protection by introducing a per period fixed cost into the lobbying function. When the fixed cost lies in a range defined by the difference in returns between lobbying and not lobbying at the initial level of capacity and at the steady-state level under protection, the industry lobbies and receives protection for some finite number of periods and then abruptly stops lobbying, resulting in a collapse in protection and accelerated adjustment. The rate of adjustment under temporary lobbying lies between the adjustment rates under permanent lobbying and no lobbying, and the associated long run output level is just the free market equilibrium.

Ultimately, the question of whether adjustment and protection are smooth or discontinuous is empirical. To the best of our knowledge, there have been no systematic investigations comparing adjustment paths across industries. Several articles that investigate a small number of industries do not address this issue directly. However, our purpose was to investigate the conditions that determine the adjustment path rather than to establish the validity of a particular path.

In addition, the paper shows quite clearly that in a partial equilibrium framework, growing industries will grow faster under endogenous protection unless there is some bias against growing industries in the political process that makes lobby formation costly. These results are suggestive for general equilibrium, where such a bias in combination with a resource constraint or a vertical relationship between infant and mature industries would result in a dynamic misallocation of resources between sectors.

Figure 1

ADJUSTMENT TO NEGATIVE SHOCK

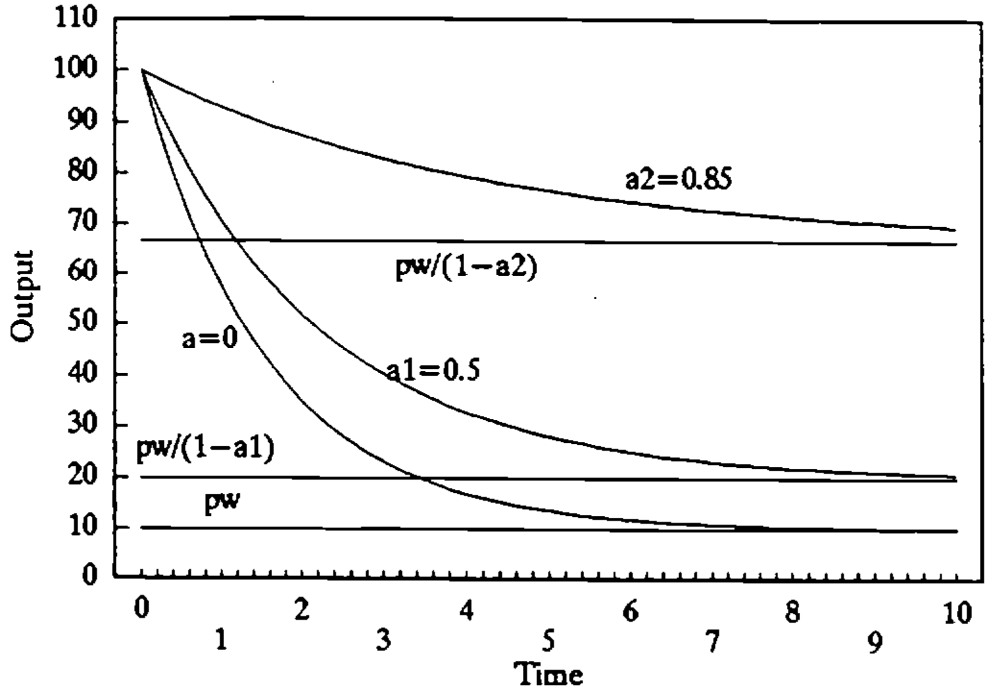
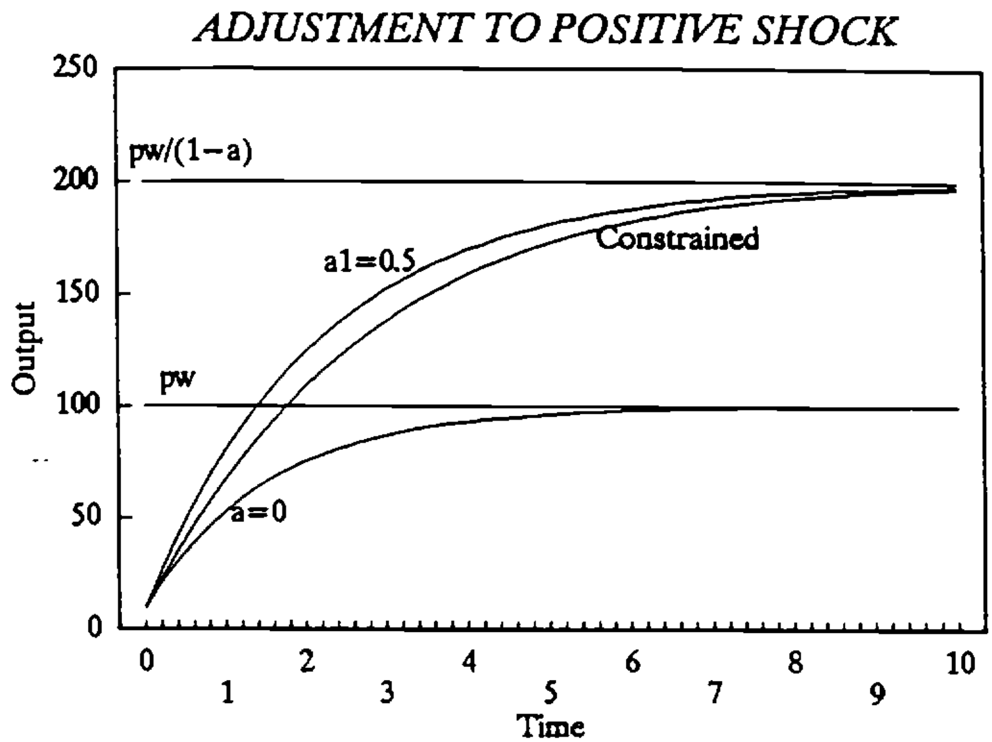


Figure 2


ADJUSTMENT TO POSITIVE SHOCK
250
200
150
100
50
0
Output
pw/(1−a)
a1=0.5
Constrained
pw
a=0
0
2
4
6
8
10
1
3
5
7
9
Time

Appendix

Assume that in order to offer a contribution schedule $F(p_t, p_w)$ to the politician, the industry must pay a fixed cost, C, in each period. Assume also that if the industry does not pay the fixed cost at any time t, then it cannot lobby in any period after t. We start by defining the value functions of the industry when it lobbies permanently, when it does not lobby, and when it lobbies for some finite number of periods and then stops.

I. Definitions and notations

1) Define $V_0(y)$ as the value function of the industry without lobbying:

(1) $$V^0(y) = Max_{0 \le z \le y}[p_w z - \frac{z^2}{2} - \frac{\phi[y-z]^2}{2} + \rho V^0(z)]$$

with $z = y-x$. Because the function $h(z,y) = p_w z - z^2/2 - \phi(y-z)^2/2$ is strictly concave and quadratic, results from Lucas and Stokey (1989) establish that there is a unique, continuous, and strictly concave value function $V_0(.)$ defined on the interval $[0,y_0]$ that satisfies this equation.

2) Further, define $V_a(y)$ as the value function of the industry with permanent lobbying on the interval $[0,y_0]$. After optimization on p, this value function is equivalent to:

(2) $$V_a(y) = Max_{0 \le z \le y} [p_w z - \frac{(1-a)z^2}{2} - \frac{\phi[y-z]^2}{2} - C + \rho V_a(z)]$$

The same result establishes that $V_a(y)$ is a well-defined, continuous and strictly concave function on $[0,y_0]$. Moreover, $V_a(y) = V_a^o(y) - C/(1-\rho)$, where $V_a^o(y)$ is the value function of permanent lobbying with zero fixed costs.

It is also useful to define an operator, T_a, that associates to any continuous function V(.) on $[0, y_0]$ the new function $(T_a V)$ defined by:

(3) $$(T_a V)(y) = Max_{0 \le z \le y} [p_w z - \frac{(1-a)z^2}{2} - \frac{\phi(y-z)^2}{2} - C + \rho V(z)]$$

$T_a V(.)$ is the value of lobbying in the current period followed by the value function V(.) in the following period. It is clear that $V_a(.)$ is the unique fixed point of this operator on the set, $C[0,y_0]$, of the continuous functions on $[0,y_0]$ (i.e. $(T_aV_a) = V_a$). Define $[T_a]^k$ as the k^{th} iterate of the operator T_a: $T_a^k \equiv T_a$ o T_a o T_a...o T_a. It is well known that for any initial continuous function V on $[0,y^0]$, the sequence of functions $([T_a]^kV)$ converges uniformly to $V_a(.)$.

3) In addition, define the two "unconstrained" operators, T_0^e and T^e_a, on the set of all functions from R to R as:

$$(4)\qquad (T_0^e V)(y) = Max_z\ [p_w z - \frac{z^2}{2} - \frac{\phi(y-z)^2}{2} + \rho V(z)]$$

$$(5)\qquad (T_a^e V)(y) = Max_z\ [p_w z - \frac{(1-a)z^2}{2} - \frac{\phi(y-z)^2}{2} - C + \rho V(z)]$$

Again drawing on results from Lucas and Stokey (1989, Theorem 4.14 and p. 95), because the functions h(z,y) defined above and $h(z,y,a)=p_wz - (1-a)z^2/2 - \phi(y-z)^2/2$ are strictly concave, quadratic in (z,y) for all $0 \leq a < 1$, the operators T_0^e and T^e_a have unique fixed points, $V_0^e(.)$ and $V_a^e(.)$ respectively, defined on R, which are well-defined, quadratic, strictly concave functions in y. The optimal adjustment paths z(0,y) and z(a,y) associated with V_0^e and V_a^e are linear and increasing in y, with a slope less than unity, such that:

- $\forall\, y \geq p_w,\ p_w \leq z(0,y) \leq y;\quad \forall\, y \leq p_w,\ y \leq z(0,y) \leq p_w.$
- $\forall a \in [0,1)$ and $\forall\, y \geq p_w/1\text{-}a,\ p_w/1\text{-}a \leq z(a,y) \leq y;$

  $\forall\, y \leq p_w/1\text{-}a,\quad y \leq z(a,y) \leq p_w/1\text{-}a.$

Consider the restriction V_0^{er} of V_0^e to $[p_w, y_0]$. It is clear that the function:

$$(6)\qquad V(y) = \left\{ \begin{array}{ll} \dfrac{2p_w y - y^2}{2(1-\rho)} & if\ \ y \in [0,\ p_w] \\ V_0^{er}(y) & if\ \ y \in [p_w,\ y_0] \end{array} \right\}$$

satisfies the fixed point property of V_0 on $C[0,y_0]$ and is therefore equal to V_0. Similarly, defining $V_a^{er}(y)$ as the restriction of V_a^e on $[p^w/1\text{-}a,\ y_0]$, it is a simple matter to verify that:

(7) $$V_a(y) = \begin{cases} \dfrac{2p_w y-(1-a)y^2-2C}{2(1-\rho)} & \text{if } y \in [0, \dfrac{p_w}{(1-a)}] \\ V_a^{cr}(y) & \text{if } y \in [\dfrac{p_w}{(1-a)}, y_0] \end{cases}$$

$V_0(.)$ and $V_a(.)$ are therefore differentiable, and using the envelope theorem yields:

(8) $$\frac{dV_0(y)}{dy} = \begin{cases} \dfrac{p_w - y}{1-\rho} & \text{for } y \in [0, p_w] \\ -\phi(y-z(0,y)) & \text{for } y \in [p_w, y_0] \end{cases}$$
and
$$\frac{dV_a(y)}{dy} = \begin{cases} \dfrac{p_w-(1-a)y}{1-\rho} & \text{for } y \in [0, \dfrac{p_w}{1-a}] \\ -\phi(y-z(a,y)) & \text{for } y \in [\dfrac{p_w}{1-a}, y_0] \end{cases}$$

From equation (8) it is clear that $V_a'(y) > V_0'(y)$ for all $y \in [0, y_0]$, and $V_a(y)$-$V_0(y)$ is increasing in y on this interval. It is also clear that $V_a^{c}(y) > V_0(y)$ on this interval. Namely, with zero fixed costs it is always better for the industry to lobby permanently than not to lobby.

4) Consider the function $(T_a V_0)(.)$, the T_a operator applied to $V_0(.)$. As before, we may consider the unconstrained program:

(9) $$(T_a^c V_0)(y) = Max_{z \geq 0}\ [h(z,y,a) - C + \rho V_0(z)]$$

Define $z^1_a(y)$ as the solution of this program, where the superscript refers to the number of iterates of the T_a operator. $z^1_a(y)$ is determined by:

(10) $$z_a^1(y) = \{\ z \mid p_w - z(1-a) + \phi(y-z) = -\rho V^{0\prime}(z)\ \}$$

Because $V_0(y)$ is quadratic, (10) establishes that for all y in $[0, y_0]$, $z^1_a(y)$ is linear and increasing in y with a slope less than unity. Also, one can verify that $z^1_a(0) > 0$. Then there is a unique point y^*_0 such that $z^1_a(y) \leq y$ if and only if $y \geq y^*_0$. Hence one may rewrite $(T_a V_0)(y)$ as:

$$(11) \qquad (T_a V_0)(y) = \begin{cases} p_w y - \frac{(1-a)y^2}{2} - C + \rho V_0(y) & \text{if } y \in [0, y_0^*] \\ (T_a^* V_0)(y) & \text{if } y \in [y_0^*, y_0] \end{cases}$$

It is clear that $(T_a V_0)(.)$ is differentiable, strictly concave, piecewise quadratic on $[0,y_0]$. Using the envelope theorem yields:

$$(12) \qquad (T_a V_0)'(y) = \begin{cases} p_w - (1-a)y + \rho V_0'(y) & \text{if } y \in [0, y_0^*] \\ -\phi(y - z_a^1(y)) & \text{if } y \in [y_0^*, y_0] \end{cases}$$

From (4) and (5), unconstrained optimal adjustment without lobbying, $z(0,y)$, and with permanent lobbying, $z(a,y)$, are determined respectively by:

$$(13) \qquad z(0,y) = \{z \mid p_w - z + \phi(y-z) = -\rho V^{0\prime}(z)\}$$

$$(14) \qquad z(a,y) = \{z \mid p_w - z(1-a) + \phi(y-z) = -\rho V_a'(z)\}$$

It follows directly from inspection of (10), (13), and (14) and the fact that on $[0,y_0]$ $V_a'(y) > V_0'(y)$ that:

- $z(a,y) > z^1_a(y) > z(0,y)$, for all $y \in [0,y_0]$

Hence, $p_w/(1-a) > y_0^* > p_w$. Using this, and comparing the expressions of $V_0'(y)$, $(T_a V_0)'(y)$ and $V_a'(y)$ obtained in (8) and (12), one concludes that:

- $V_a'(y) > (T_a V_0)'(y) > V_0'(y)$ for all $y \in [0,y_0]$

In particular, we conclude that $(T_a V_0)(y) - V_0(y)$ is increasing in y.

5) Now consider the t^{th} iterate of the T_a operator applied to V_0. For all $t \geq 1$ and all $y \in (0,y_0]$, one may construct $([T_a]^t V_0)(y)$ recursively, given that $([T_a]^{t-1} V_0)(y)$ is a differentiable, strictly concave, piecewise quadratic function on $[0,y_0]$. Let $z_a^t(y)$ be the solution of the following unconstrained program:

$$(15) \qquad ([T_a^*]^t V_0)(y) = Max_{z \geq 0} \; [h(z,y,a) \; - C + \; \rho([T_a]^{t-1} V_0)(z)]$$

Then $z_a^t(y)$ is the solution of the following equation:

$$(16) \qquad z_a^t = \{z \mid p_w - z(1-a) + \phi(y-z) = -\rho([T_a]^{t-1} V_0)'(z)\}$$

Because $([T_a]^{t-1} V_0)(y)$ is concave and piecewise quadratic, (16) shows that for all y in $[0, y_0]$, $z^t_a(y)$ is a linear, increasing function in y with a slope less than unity. In addition, $z^t_a(0) > 0$. So there is a unique point, y^*_t, such that $z^t_a(y) \leq y$ if and only if $y \geq y^*_t$. Hence, one may rewrite $([T_a]^t V_0)(y)$ as:

$$(17) \quad ([T_a]^t V_0)(y) = \begin{cases} p_w y - \frac{(1-a)y^2}{2} - C + \rho([T_a]^{t-1} V_0)(y) & \text{if } y \in [0, y_t^*] \\ ([T_a^c]^t V_0)(y) & \text{if } y \in [y_t^*, y_0] \end{cases}$$

Using the envelope theorem, it is a simple matter to see that $([T_a]^t V_0)(.)$ is differentiable, strictly concave, and piecewise quadratic on $[0,y_0]$ and:

$$(18) \quad ([T_a]^t V_0)'(y) = \begin{cases} p_w - (1-a)y + \rho([T_a]^{t-1} V_0)'(y) & \text{if } y \in [0, y_t^*] \\ -\phi(y - z_a^t(y)) & \text{if } y \in [y_t^*, y_0] \end{cases}$$

Now we show by forward recursion the following property for $\tau \geq 1$:

- $z_a^{t-1}(y) < z_a^t(y) < z(a,y)$ and $([T_a]^{t-1} V_0)'(y) < ([T_a]^t V_0)'(y) < V_a'(y)$ for all $y \in [0,y_0]$ and all $t \leq \tau$.

Our discussion of $(T_a V_0)$ showed that this property is true for $t=1$ (where $z(0,y) = z^0_a(y)$ with the previous notation). Assume the property is also true for $\tau > 1$. Then it is clear that for all $t \leq \tau$, $y^*_{t-1} < y^*_t < p_w/(1-a)$. To show that the property is true for $\tau+1$, we need only show that:

- $z^\tau_a(y) < z_a^{\tau+1}(y) < z(a,y)$ and $([T_a]^\tau V_0)'(y) < ([T_a]^{\tau+1} V_0)'(y) < V_a'(y)$.

The first part of the assertion follows directly from $([T_a]^{\tau-1} V_0)'(y) < ([T_a]^\tau V_0)'(y) < V_a'(y)$, equation (16), and the fact that $([T_a]^t V_0)(y)$ is a strictly concave function in y. The second part follows directly from (18).

Thus, the previous discussion establishes:

Lemma 1: For all $y \in [0,y_0]$, for all $t \geq 1$,

i) The value function $([T_a]^t V_0)(y)$ is differentiable and strictly concave.

ii) $([T_a]^t V_0)(y)$ - $([T_a]^{t-1} V_0)(y)$ is increasing in y.

iii) $z^{t-1}_a(y) < z^t_a(y) < z(a,y)$ for all $y \in [0,y_0]$ and $t > 0$.

II. The problem of lobbying with fixed costs

We are now equipped to solve the problem of lobbying with fixed costs. In any period when the industry has lobbied in the previous period, the industry chooses between lobbying and not lobbying. The value to an industry with an initial size y_0 of t periods of lobbying followed by no lobbying is simply $([T_a]^t V_0)(y_0)$. The basic problem then is:

(A) $\quad \text{Max}_{t\geq 0} \; ([T_a]^t V_0)(y_0)$

If the argmax of this problem is ∞, then permanent lobbying will prevail. Otherwise, the industry stops lobbying after a finite number of periods and loses protection. We start by showing the following lemma:

Lemma 2: For all $y_0 > p_w/1\text{-}a$,

i) If for some $t \geq 1$, we have $([T_a]^t)V_0(y_0) \leq ([T_a]^{t-1})V_0(y_0)$, then for all $k > 0$, we also have $([T_a]^{t+k} V_0)(y_0) < ([T_a]^{t+k-1})V_0(y_0)$.

ii) If for some $t \geq 1$, we have $V_a(y_0) \leq ([T_a]^t V_0)(y_0)$, then for all $k > 0$, we also have $V_a(y_0) < ([T_a]^{t+k} V_0)(y_0)$.

Proof:

i) Consider $t \geq 1$, such that $([T_a]^t V_0)(y_0) \leq ([T_a]^{t-1} V_0)(y_0)$. Since $([T_a]^t V_0)(y) - ([T_a]^{t-1} V_0)(y)$ is increasing on $[p^w, y_0]$, we conclude that for all y in $[p_w, y_0)$, $([T_a]^t V_0)(y) < ([T_a]^{t-1} V_0)(y)$. Therefore, as $z^{t+1}_a(y) > p^w$ for y in $[p^w, y_0]$, we get:

$$(19) \quad ([T_a]^{t+1} V_0)(y) = h(Min[z_a^{t+1}(y),y],y,a) - C + \rho([T_a]^t V_0)(Min[z_a^{t+1}(y),y])$$
$$< h(Min[z_a^{t+1}(y),y],y,a) - C + \rho([T_a]^{t-1} V_0)(Min[z_a^{t+1}(y),y]) \leq ([T_a]^t V_0)(y)$$

Hence, $T_a^{t+1} V_0(y_0) < T_a^t V_0(y_0)$. Using a similar argument, we can show by recursion that for all $k > 0$ we also have for all y in $[p^w, y_0]$, $([T_a]^{t+k}) V_0)(y) < ([T_a]^{t+k-1}) V_0(y)$. Result i) follows immediately.

ii) Consider $t \geq 1$, such that $V_a(y_0) \leq ([T_a]^t V_0)(y_0)$. As $V_a(y) - ([T_a]^t V_0)(y)$ is increasing in $[p^w, y_0]$, we conclude that for all y in $[p^w, y_0)$, $V_a(y) <$

$([T_a]^t V_0)(y)$. Therefore, since $z(a,y) > z^t_a(y) > p^w$ for y in $[p^w, y_0]$, we get:

$$(20)\quad V_a(y) = h(Min[z(a,y),y],y,a) - C + \rho V_a(Min[z(a,y),y]) < h(Min[z(a,y),y],y,a) - C + \rho([T_a]^t V_0)(Min[z(a,y),y]) \leq ([T_a]^{t+1} V_0)(y)$$

Hence, $V_a(y_0) < ([T_a]^{t+1} V_0)(y_0)$. Using a similar argument, we can show by recursion that for all $k > 0$ we also have for all y in $[p^w, y_0]$, $V_a(y) < ([T_a]^{t+k} V_0)(y)$, and result ii) follows immediately.

Lemma 2 i) implies that if problem (A) has a finite solution, there are at most two points τ and $\tau + 1 < \infty$ that can be the solution. Hence, unless y_0 belongs to a set of isolated points y (such that $([T_a]^\tau V_0)(y) = ([T_a]^{\tau+1}) V_0(y))$ there is at most one finite solution $\tau(y_0)$ to problem (A). Note that Lemma 2 i) holds for all $C > 0$.

Defining T_a^o as the operator T_a associated with zero fixed costs, and recalling that V_a^o is the value of permanent lobbying with zero fixed costs, we rewrite $([T_a]^t V_0)(y)$ as $([T_a^o]^t V_0)(y) - C[1-\rho^t]/[1-\rho]$, and $V_a(y)$ as $V_a^o(y) - C/[1-\rho]$. Temporary lobbying will arise if and only if:

- $\exists\, t < \infty$ such that $([T_a]^t V_0)(y_0) > V_a(y_0)$

or equivalently:

- $\exists\, t < \infty$ such that $C/[1-\rho] > [V_a^o(y_0) - ([T_a^o]^t V_0)(y_0)]/\rho^t$.

It is clear that $V_0(y) < V_a^o(y)$ for all $y > 0$. Then by recursion $([T_a^o]^t V_0(y)) < V_a^o(y)$ for all $y > 0$. Also, since $V_0(0) = (T_a^o V_0)(0) = 0$ and $([T_a^o] V_0)(y) - V_0(y)$ is increasing in y, it is clear that $V_0(y) < ([T_a^o] V_0)(y)$ for all $y > 0$. By recursion one can also see that $([T_a^o]^t V_0)(y) < ([T_a^o]^{t+1} V_0)(y)$ for all $y > 0$. Finally, we can conclude that the sequence of points $([T_a^o]^t V_0)(y_0)$ is monotonically converging to $V_a^o(y_0)$ from below.

Let us define $u_t = [V_a^o(y_0) - ([T_a^o]^t V_0)(y_0)]/\rho^t$. Then the condition, $\exists\, t < \infty$ such that $([T_a]^t V_0)(y_0) > V_a(y_0)$, is equivalent to the condition: $\exists\, t < \infty$ such that $C/[1-\rho] > u_t$.

Lemma 3: The sequence of points $(u_t)_t$ is a decreasing sequence (ie. $u_t \geq u_{t+1}$ for all $t \geq 0$).

Proof: Suppose the contrary: $\exists$ t such that $u_t < u_{t+1}$. Then one can choose a level of fixed cost C such that $u_t < C/[1-\rho] < u_{t+1}$. This implies that $\exists t < \infty$ such that: $([T_a]^t V_0)(y_0) > V_a(y_0)$ and $([T_a]^{t+1} V_0(y_0)) < V_a(y_0)$. This contradicts Lemma 2 ii).

Since it is a decreasing, positive sequence, $(u_t)_t$ converges towards a limit $u \geq 0$. The following proposition guarantees that this limit is strictly positive:

Proposition 1: If $V_a(p^w) > V_0(p^w)$, i.e. $C < ap_w^2/2$, then there is permanent lobbying and permanent protection. In this case, the adjustment path is given by $y_{t+1} = z(a, y_t)$ with the initial condition y_0.

Proof: Given that $V_a'(y) > V_0'(y)$ for all $y \in [p^w, y_0]$, $V_a(p_w) \geq V_0(p_w)$ implies that $\forall y \in [p_w, y_0]$, $V_a(y) \geq V_0(y)$. Therefore, by recursion, $\forall y \in (p^w, y_0]$, $V_a(y) > ([T_a]^t V_0)(y)$ for all $t \geq 1$. Thus, for all $t \geq 0$, $V_a(y_0) > ([T_a]^t V_0)(y_0)$, which says that it is always beneficial for the industry to continue lobbying. Consequently, we conclude that for any $y_0 \geq p_w/(1-a)$, there is permanent lobbying and protection. The adjustment process y_t and domestic protection p_t are such that $y_t = z(a, y_{t-1})$, and $p_t = p^w + az(a, y_{t-1})$.

A corollary follows directly from this proposition:

Corollary 1: For all $t \geq 0$ and all $C \leq ap_w^2/2$, $u_t > C/[1-\rho]$. Hence $u = \mathrm{Lim}\, u_t \geq ap_w^2/2[1-\rho] > 0$.

We are now able to state our main result:

Proposition 2:

i) If the fixed cost C is such that $C/[1-\rho] \leq u$, then there is permanent lobbying and protection never collapses.

ii) *If the fixed cost C is such that $C/[1-\rho] > u$, then there exists a unique time $\tau(y_0) \geq 0$, such that the industry enjoys temporary protection for $\tau(y_0)$ periods, after which it stops lobbying and protection collapses.*

iii) *When protection is temporary, the adjustment path during the lobbying periods always lies between the free trade and permanent lobbying adjustment paths.*

Proof:

i) If C is such that $C/[1-\rho] \leq u$, then for all t, $C/[1-\rho] < u_t$, which is equivalent to $V_a(y_0) > ([T_a]^t V_0)(y_0)$. Hence, permanent lobbying is optimal.

ii) If C is such that $C/[1-\rho] > u$, then, because u_t is decreasing (except in the case where y_0 belongs to a set of isolated points such that $([T_a]^t V_0)(y) = ([T_a]^{t+1} V_0)(y)$), there exists a unique t such that:

$u_t = [V_a^o(y_0) - ([T_a^o]^t V_0)(y_0)]/\rho^t > C/[1-\rho]$ and $C/[1-\rho] > u_{t+1} = [V_a^o(y_0) - ([T_a^o]^t V_0)(y_0)]/\rho^t$. Then for all $t' > t+1$, $([T_a]^{t'} V_0)(y_0) > V_a(y_0)$. Moreover, since the sequence $([T_a]^{t'} V_0)(y_0)$ converges to $V_a(y_0)$, there is a point, $\tau(y_0) > t$, that reaches the sup $([T_a]^{t'} V_0)(y_0)$. By Lemma 2 this point, $\tau(y_0)$, is unique for almost every $y_0 > p_w/(1-a)$. Obviously, then it is optimal for the industry to lobby for $\tau(y_0)$ periods, and then to stop lobbying. Thus, there is temporary protection for $\tau(y_0)$ periods.

iii) This follows immediately from Lemma 1 iii) and the fact that at time t along the adjustment path, $y_{t+1} = \mathrm{Min}(y_t, z_a^t(y_t))$.

An immediate corollary is:

Corollary 2: If $([T_a]V_0)(y_0) < V_0(y_0)$, then there is no lobbying and no protection along the adjustment path.

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