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Lobbying, Innovation, and protectionist cycles

Gabriel A. Sanchez

QUAERERE VERUM

Universidad de San Andres

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Gabriel A. Sánchez*
Columbia University
gas10@columbia.edu
(212) 666-7196
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Abstract: This paper explains the time path of trade policies in developing countries by focusing on the use of lobbying for protection by import competing firms as a mean to postpone costly technological adjustments to keep up with the product quality upgrading by foreign competitors. Given the availability of a political market for import tariffs, domestic firms will lobby for a sequence of tariffs that insulate domestic profits from a widening quality gap, thereby allowing to postpone adjustment. However, as the contributions required by the government grow with the size of the quality gap, it will be optimal to adjust quality and to decrease the lobbying effort at some point in time, leading to liberalization and technological catch-up. But at this point the equilibrium tariff will be again small and "cheap", and it will pay to start lobbying anew, until the next quality adjustment. The model thus sheds new light on the impact of the costs of protection on the effectiveness of the lobbying effort over time, and on their implications for the timing and the time horizon of trade reforms in developing countries, predicting the occurrence of protectionist cycles.

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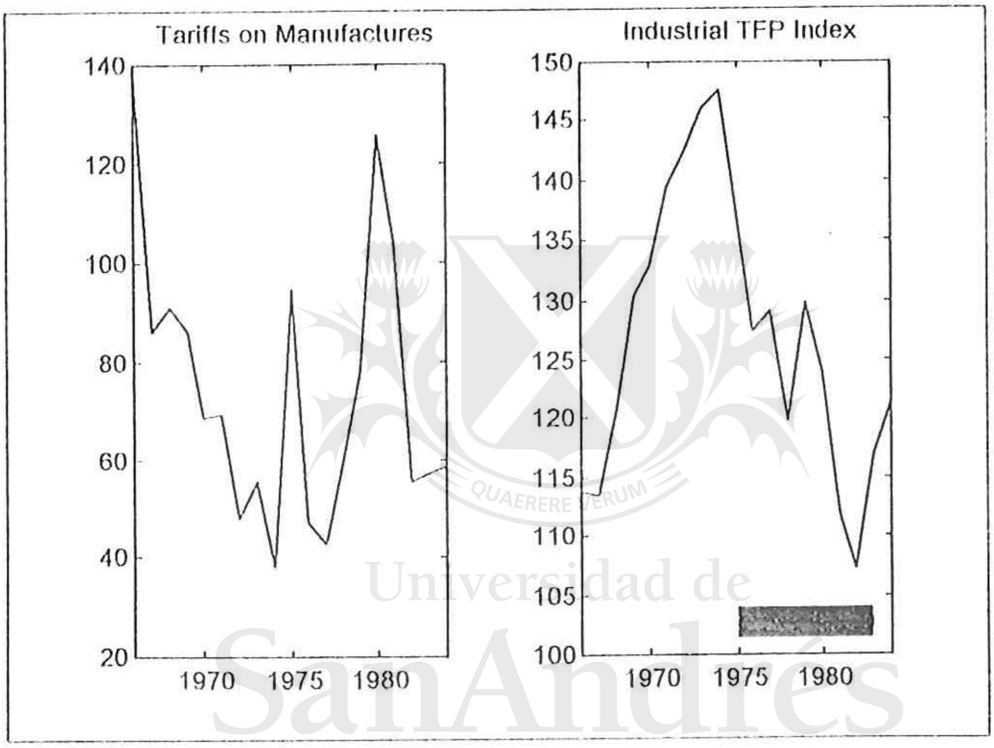
I. Introduction:

A remarkable feature in recent times has been the dramatic turnaround in the trade policy stance adopted by a large number of developing countries, which drastically reduced their barriers to imports of foreign goods. Given that most of these countries had overwhelmingly adopted inward-looking strategies for several decades, and that the persistence of protectionism in these economies has been explained mostly in terms of interest-group lobbying activity, it is worth inquiring what are the forces behind this switch to freer trade, and whether liberalizations will be permanent, or simply temporary. Such will be the aim of this paper, which will attempt to shed light on this issue by focusing on the dynamic costs (in the form of poor growth and technological change) that endogenous protection may generate, and on the impact of these costs on the effectiveness of the lobbying effort.

It bears particular importance to determine the time horizon of these liberalizations, given that in the past there have occurred several episodes of temporary liberalization, followed by reversals to protectionism (Sachs and Warner, 1995; Papageorgiu et al, 1991), and that there already are some notorious recent examples of a revival of effective lobbying for protection, disguised as measures to countervail balance of payment problems (International Monetary Fund, 1994), suggesting the existence of protectionist cycles in developing countries. Furthermore, there exists evidence ascribing these protectionist phases a deleterious effect on technological upgrading in these countries (Little et al, 1970; Katz, 1987), which is consistent with the evidence found regarding the negative association between closed trade policies and productivity growth (Harrison, 1994; Krishna and Mitra, 1994), and regarding the negative impact of protectionism on growth both directly and through investment (Sachs and Warner, 1995; Harrison, 1996). Sachs and Warner also found that the recent episodes of trade liberalization were associated with a strong acceleration of growth with respect to the past, and that while the past episodes of temporary trade liberalization were accompanied by high growth, the subsequent reversals to protectionism witnessed poor growth performances. An illustrative example of the fluctuations in protection and of the associated productivity performance is provided by the evolution of the direct nominal tariffs on manufactured goods and of the sectoral Total Factor Productivity and in Argentina between 1966 and 1984, presented in Figure 1 below.

Figure 1



Sources: Sturzenegger (1987), Elias (1988).

In this vein, I will hypothesize that there is a direct effect of closed trade policies on technological backwardness, that is perceived by policymakers, and which weakens the power of trade lobbyists, leading to a liberalization as the technological gap reaches an intolerable level.[1]

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[1] This intuition is well captured in the following quotation from Leamer (1996), pp 2-3: "The view offered here is that at the end of World War II countries sorted themselves into two different groups. Europe and Japan and the Asian NICs chose economic integration with the United States. But most of the rest of the world opted for inward looking isolationist policies. Those that chose integration experienced a period of

The scenario analyzed is one in which the political system makes available a market for protection that is viewed by domestic firms as a means to postpone costly innovation to keep up with the technology or quality upgrading by foreign competitors. If the cost of lobbying is initially low, and endogenous tariffs insulate profits from the negative impact of an increasing technological backwardness, we could observe both increasing protection levels and a widening in the quality gap with foreign competitors. However, if the cost of lobbying increases with the size of the tariff, as it probably will if the government factors in the welfare losses induced by the tariffs, a point may be reached in which innovating and decreasing the lobbying effort become more profitable than continuing to lobby without adjusting. At this point, "liberalization" and catching-up would take place. But once the adjustment has occurred, the tariff needed to keep up with subsequent foreign quality upgrading will most likely be again small and politically inexpensive, thus leading to the possibility of a new growth in protection.

In the model developed here, domestic firms engage in Bertrand competition with foreign producers that are upgrading product quality at a constant and exogenous rate. Domestic firms must incur in a fixed cost to imitate the foreign quality improvements, and in the absence of protection they do not continuously imitate, but rather define a sequence of intervals of constant duration during which domestic quality is held constant, followed by a catch-up to foreign quality between intervals. Prices and operating profits are falling withing each interval as a result of the widening quality gap, experiencing upward jumps at the time of the adjustment. When a market for endogenous protection is made available, the firms lobby for sequences of increasing tariffs that offset the effect of the widening quality gap over prices and profits, mitigating the need for adjusment. However, the contributions required by the government will rise with the size of the

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technological backwardness, but the technological lead that the US enjoyed in the 1960's vis-a-vis the integrated economies dissipated rapidly in the 70s even as the gap increased vis-a-vis the isolated countries. Economic isolationism eventually collapsed as this technological gap became more and more intolerable".

tariff, and domestic firms will still find it profitable to adjust quality at intervals of constant, but longer, duration, and to simultaneously reduce the lobbying effort. At this point, the equilibrium tariff experiences a discrete reduction, and a liberalization ensues, but is followed by a new protectionist escalade as the quality gap widens again. When political preferences for lobbyists' welfare are relatively high the firm never ceases to lobby, and the liberalization is partial. When these preferences are relatively low, it is optimal for the firm to stop lobbying at the time of the adjustment, thereby allowing a full liberalization and temporary free trade, and to start lobbying again only when the quality gap has reached a certain threshold.

The link posited here between increasing technological backwardness and high and persistent protection finds support in several empirical studies of the costs of protection in developing countries, where it was found that for many protected industries in developing countries in the 1960s, the value of domestic output at world prices was less than the value of tradable inputs at world prices; i.e., these activities were not viable without protection. Some examples from India were given by the industries producing bicycles, non-ferrous metals, matches, sewing machines, and motor-cars (Little et al, 1970). An important example is the Indian Ambassador automobile: the original model remained unchanged for 30 years, despite global advances in this industry (Evenson and Westphal, 1994). Another good example is the Acindar steel firm in Argentina, whose first plant was built during World War II and kept in operation without major improvements in an isolated environment until 1978, despite having been acknowledged as obsolete fifteen years before that (Maxwell, 1987). Further supporting evidence comes from the study by Katz et al (1987) of the technological behavior of a rayon manufacturer in Argentina: during the initial 12-year period during which the company enjoyed the status of a protected monopolist no innovations were introduced; however, during the subsequent period when it faced the competitive pressure of new entrants it concentrated on introducing quality improvements and on reducing costs.

The model presented here thus provides a new insight regarding the time path of trade policies in developing countries. If the protectionist regimes adopted in the past were motivated to a significant extent by domestic firms seeking to postpone costly adjustments, once liberalization and adjustment have taken place it may become profitable for the domestic firms to eventually start lobbying for a new protectionist escalade to postpone subsequent adjustments. Within the context of this model, movements towards permanent free trade would occur through declines in political preferences for campaign contributions and in the costs of imitation. These findings contrast with the most frequent explanation for these liberalizations en masse provided by the literature, which is that the economic debacle of the 1980s weakened the power of domestic lobbies and relegated distributional considerations to a second plane, thus facilitating the reform by agenda-setting technocrats, which ascribed as the costs of protection only the traditional static Harberger triangles (Rodrik, 1994).

There exists a vast literature explaining the endogenous formation of commercial policies in a static framework (Findlay and Wellisz (1982), Mayer (1984), Brock, Magee and Young (1989), Grossman and Helpman (1994)). This literature, while providing useful insights, falls short of explaining the time path of endogenous protection and of generating predictions about the time horizon of trade liberalizations. Hence, it appears necessary to develop theoretical models for endogenous protection in a dynamic framework, where the trade policies implemented are the result of political-economic equilibria that are changing over time, as a result of the economic consequences of the policies adopted, as suggested by Krueger (1993). Some pioneering work in this area has been done by Fernandez and Rodrik (1991), Brainard and Verdier (1994), and Maggi and Rodriguez-Clare (1996).

In Section 2 I present a model of quality adjustment for domestic firms, in an economy in which firms compete with foreign producers that are continuously updating the quality of their products, and in which endogenous protection is not available. In Section 3, I introduce the availability of a political market for endogenous tariffs, and derive the equilibrium tariffs and their time path, and the optimal policy for quality adjustment in the presence of lobbying. In Section 4, I present the main conclusions, and suggest extensions to this line of research.

2. A Model of Quality Adjustment

In this section I analyze the optimal quality adjustment policy for "Southern" firms that engage in Bertrand competition with "Northern" producers which are upgrading product quality at a constant and exogenous rate. The main result of this section is that under the assumption of fixed costs to imitation the optimal policy for domestic firms will be to keep product quality unchanged over intervals of constant duration, and to catch up to foreign quality between intervals. As a result of the widening of the quality gap between Northern and Southern goods, prices and profits will fall continuously within each interval, experiencing discrete increases at the time of the quality adjustment. Import will tariffs dampen the effects of a widening quality gap on prices and profits, allowing to postpone imitation.

I consider the behavior of producers of differentiated goods in a "Southern" economy. By "Southern" I signify an economy in which domestic firms possess the ability to imitate quality improvements by competitors in the "North" (developed countries), but not to leapfrog them, and that can compete with the Northern producers by virtue of lower domestic wages. There is a continuum of differentiated "hi-tech" goods indexed by $j \in [0,1]$, with one domestic firm per product line.[2] I do not allow free entry. Each Southern firm will engage in Bertrand (duopoly) competition for its domestic market with a foreign producer. The domestic and the foreign firms

[2] This assumption of only one domestic firm per product line can be justified by barriers to entry, private product specific knowledge, etc.

offer goods that are perfect substitutes, and that may differ only in their quality levels. Therefore, the demand for a domestic good will depend on both its price and its quality with respect to the rival foreign good. There is another productive sector that manufactures a homogeneous good that is perfectly tradable in international markets. There exist two types of agents, workers, who are also the consumers, and entrepreneurs who own the firms and do not consume at home.[3] Intertemporal preferences over consumption are defined by

(1) $$U_0 = \int_0^\infty \log D(t) e^{-\rho t} dt,$$

where $D(t)$ is a consumption index of the differentiated and homogeneous goods, and ρ is the domestic rate of time preference. Instantaneous utility is defined over the consumption index $D(t)$ as in Grossman (1990) by

(2) $$\log D(t) = s_x \int_0^1 \log\left[\sum_m q_m(j) x_{mt}(j)\right] dj + (1 - s_x) \log(y_t)$$

where $q_m(j) = e^{\lambda m}$ represents the quality of the differentiated good j after m improvements and $x_{mt}(j)$ denotes consumption of quality m of product type j at time t ; y_t denotes the consumption of the homogeneous good at time t ; and s_x denotes the expenditure share on differentiated goods. At any point in time there will exist several generations (number of quality improvements) for each differentiated good, but in equilibrium, only the goods with the lowest quality-adjusted price will be consumed in each product line, because the goods in each product line are perfect substitutes. Given the wage differential between North and South there will be only one producer in the market in each period. I choose units so that the lowest quality of each product (the one available at time $\tau = 0$) offers one unit of service; i.e., $q_0(j) = 1$. As in Grossman (1990), solving (1) and (2)

[3] The assumption that entrepreneurs do not consume at home is made only to simplify the analyisis. The results of the paper do not hinge on this assumption. The results are also robust to changes in the assumption regarding the distribution of the ownership of the firms.

subject to the corresponding static and dynamic budget constraints [4], and normalizing nominal expenditures to one, yields the following demand functions, where nominal expenditures have been chosen as the numeraire:

(3) $$x_t(j) = \frac{s_x}{p_t(j)}$$ (4) $$y_t = \frac{1 - s_x}{p_t^y}$$

where $x_t(j)$ is the quantity demanded at a price $p_t(j)$ of the good that has the lowest quality-adjusted price within the product line j, and y_t is the quantity demanded of the homogenous good at a price p_t^y. The only factor employed in the production of all goods is unskilled labor. Technologies for the production of differentiated goods exhibit constant returns to scale, and are assumed to be identical across all goods j and all qualities q, and to be the same in the North and the South, $x(j) = l_x(j)$, where $l_x(j)$ is the amount of labor employed in the product line j. The production function of the homogeneous good also displays constant returns to scale, $y = cl_y$, where c is the productivity of labor l_y employed in this sector. Under these assumptions, domestic wages (and hence the unit cost of production for the differentiated goods) will be determined as the marginal value product of labor in the y sector, whose price is determined in international markets,

[4] Consumers will choose an optimal time pattern for spending and by allocating spending optimally at each point in time. Given prices $p_{mt}(j)$ for the differentiated goods, p_{yt} for the homogeneous good, and given expenditure $E(t) = \int_0^1 \left[\sum_m p_{mt}(j) x_{mt}(j) \right] dj + p_{yt} y_t$, consumers maximize (2) by allocating a share s_x of spending to high-tech goods and spreading this evenly across product types. Substituting into (1), we get the indirect utility function $U_0 = \int_0^{\infty} \left\{ \log E(t) - s_x \int_0^1 \log\left[p_t(j) / q_t(j) \right] dj - (1 - s_x) \log p_{yt} \right\} e^{-\rho t} dt$, where $p_t(j) / q_t(j)$ denotes the lowest quality-adjuste price for each j, which is maximized over $E(t)$. The dynamic budget constraint is given by $\dot{B}(t) = w(t) + r(t)B(t) - E(t)$, were $B(t)$ is the value of financial asset holdings at time t, $w(t)$ denotes wage income, and $r(t)$ is the interest rate. I assume here that there exists perfect international capital mobility, with the domestic rate of time preference being equal to the given international interest rate. Nominal expenditure will thus be constant, and can be normalized to one. The inclusion of entrepreneurs as consumers would not change the results regarding the time pattern of spending, since it would also be optimal for them to smooth consumption expenditure over time.

(5) $p_x = p_x^f$ (6) $w = cp_x^f$

In order to ensure the competitiveness of domestic firms, it is assumed that wages are lower in the South than in the North.[5] The equilibrium in the labor market is given by $L = \int_0^1 s_x / p(j)dj + L_y$, where the integral represents the employment in the differentiated goods sector, and L_y the employment in the homogenous good sector. The endowment of unskilled labor is assumed to be large enough as to ensure the production of all the differentiated goods and of the homogeneous good, $L > \int_0^1 \max l_x(j)dj = s_x / w$; i.e., the total labor force is larger than the maximum employment level that can attain in the differentiated goods sector.[6] All workers that are not employed in this sector employ themselves in the homogeneous good sector.

Given all these preliminaries, attention is now turned to the determination of the outcomes of Bertrand competition in the domestic markets between the domestic producer in each product line and its Northern competitors. Since there is no free entry, the problem will be symmetric to firms in all product lines, and I can thus focus on the behavior of a representative firm and drop the j subscript. Bertrand competitors will engage into limit pricing: given demand functions with unit price elasticities, domestic firms will price at (a shade below) the marginal cost of the foreign rival, w^N, adjusted by relative quality. To see this, let domestic quality be q_i and relative quality be $z_i = q_i / q_i^f$. Since the minimum quality-adjusted price that the foreign producer can charge is w^N / q_i^f, the domestic producer will charge a price

(7) $p(z_i) = z_i w^N$

[5] The implicit assumption is that Northern workers are more productive in the homogenous good sector.
[6] The minimum price that a domestic firm can charge is its unit cost of production, w, and hence the level of employment in the differentiated goods sector can never exceed s_x / w.

such that it offers a lower quality-adjusted price. The operating profits obtained by the Southern firm will thus be a function of the relative quality, z_t. The higher the quality gap, the lower the price, and the lower the profits.

$$F(z_t) = s_t\left[1 - \frac{w}{z_t w^N}\right] \qquad F' > 0, F'' < 0 \tag{8}$$

Having determined the outcome of the Bertrand competition in each product line as a function of the quality gap between the Northern and Southern goods, we can now focus attention on the determinants of the quality gap. The quality of foreign goods in all product lines is assumed to be growing at constant given rate λ per unit of time, that is perfectly anticipated by the domestic firms. If the initial foreign quality level is $q_0^f = 1$, the quality level at time t is $q_t^f = e^{\lambda t}$.[7] In the absence of adjustment costs the optimal policy for a representative firm would be to continuously imitate foreign quality improvements. I assume, however, that a Southern firm can imitate the quality of the state-of-the-art good developed in the North by incurring in a fixed real cost β, which is independent of the size of the quality gap. This is a very important assumption, which can be motivated by the verified importance of the spillovers from foreign innovations on the effectiveness of inventive activity in developing economies, and by the poor protection of foreign intellectual property rights in these countries.[8] As a consequence of the fixed costs to imitation, the

[7] The Southern economy is assumed to be small, in the sense that domestic firms do not possess the capacity to export to world markets, and that the domestic market is marginal to foreign producers. Therefore, the actions of the domestic firms do not affect the innovation decisions by the Northern firms.
[8] Evenson and Westphal (1994) point out that most technological development in developing countries starts and builds on transfers (of various kinds, including spillovers) of technology from more advanced countries, and that technological development is intertwined with the various forms of international trade that involve technology. In analyzing the basic search model, which provides for changes over time in the pool of knowledge and is supported by ample evidence from developing countries, they also point out that new "germplasm" in the form of potentially adaptable inventions from foreign sources shifts to the right the distributions of outcomes of R&D in developing countries. Thus, the assumption made here that there are strong spillovers from Northern innovations, leading to a constant cost β for imitation independently of the size of the quality gap is not altogether unreasonable. The mechanism presented here is also consistent with the models of diffusion of innovation, which link the timing of the adoption of new inventions to the costs of adoption, the adoption by competitors, the expected benefits, and the expectation

optimal adjustment policy is characterized by a sequence of intervals during which domestic quality is held constant, followed by discrete quality adjustments.[9] The Southern firm will solve this problem in the following fashion. Suppose at $t_0 = 0$ the firm plans to adjust its quality at the points of time $0 < t_1 < t_2 < t_3 < \ldots < t_\tau < \ldots$ Respectively denote the fixed domestic quality and the relative quality in the interval $[t_\tau, t_{\tau+1})$ by q_τ and $q_\tau e^{-\lambda t}$.[10] The profits during this interval, including the adjustment costs at time $t_{\tau+1}$ are given by:

(9) $$\int_{t_\tau}^{t_{\tau+1}} F(q_\tau e^{-\lambda t}) e^{-rt} dt - \beta e^{-rt_{\tau+1}}$$

Long run profits are obtained by summing (9) over τ :

(10) $$V_0 = \sum_{\tau=0}^{\infty} \left[\int_{t_\tau}^{t_{\tau+1}} F[q_\tau e^{-\lambda t}] e^{-rt} dt - \beta e^{-rt_{\tau+1}} \right]$$

where initial quality is assumed to be $q_0 = 1$, and $t_0 = 0$. The firm's objective will be to choose sequences $\{t_\tau\}, \{q_\tau\}, \tau = 1,2,\ldots$ that maximize V_0, subject to $q_\tau \leq e^{\lambda t_\tau}$. The solution to this problem is presented in Appendix A. Since operating profits grow monotonically on domestic quality and the cost of imitation is independent of the size of the quality gap, the Southern firm will always catch up with the latest quality developed in the North at the time of the adjustment, and thus,

(11) $$q_\tau = e^{\lambda t_\tau}$$

Regarding the periodicity of the adjustments, the firm will define a sequence of intervals during which domestic quality is held constant, followed by a catch up to foreign quality. The length of these intervals is determined by the first order condition with respect to t_τ,

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of the introduction of new inventions (Reiganum, 1989; Evenson and Westphal, 1994). The costs of adoption can be expected to be low, given the findings in Mansfield et al (1981), that in a study of 48 product innovations the costs of imitation averaged 65 percent of the cost of the original innovation. Finally, while there will be industries for which this assumption may be unrealistic, there will be others in which the imitation will be attainable through turnkey projects, imports of machinery, or copying of blueprints.

[9] The problem faced by the domestic producer is similar to that analyzed by Sheshinski and Weiss (1977) of a monopolist that faces a fixed real charge to adjust nominal prices in response to a perfectly anticipated deterministic rate of inflation.

(12) $\quad F[q_t e^{-\lambda t_t}] = F[q_{t-1} e^{-\lambda t_t}] + \rho\beta + \mu_t(\lambda - \rho)e^{\lambda t_t}$

which states that the gains from postponing imitation, given by the profits just before the quality adjustment, $F[q_{t-1}e^{-\lambda t_t}]$, the interest saved on the adjustment costs, $\rho\beta$, plus the effect of increasing t_t on the present discounted value of the marginal return from relaxing the quality constraint, $\mu_t(\lambda - \rho)e^{\lambda t_t}$ [10], must be equal to the loss from the postponement, given by the profits just after the adjustment, $F[q_t e^{-\lambda t_t}]$. In Appendix A it is shown that the length of these intervals, $\{t_t - t_{t-1}\}$, denoted by ε, will be constant and unique, and implicitly determined by:

(13) $\quad e^{\lambda\varepsilon} - e^{(\lambda-\rho)\varepsilon} = \dfrac{w^N}{s_t w}\rho\beta$

Therefore, in the presence of fixed costs to imitation and of constant foreign quality upgrading, the firm will choose to adjust its quality at intervals of finite length ε. The duration of these intervals will increase with domestic competitiveness, as measured by the wage differential w^N / w, as the ensuing increase in operating profits at all levels of the quality gap will allow to postpone the adjustment. It will also increase with the cost of adjustment, β: the firm will adjust continuously only if $\beta = 0$. Finally, the length of the interval will decrease with the rate of growth of foreign quality. A higher λ will increase the marginal return from relaxing the quality constraint, but it will also decrease prices and profits in every period, with the second effect prevailing. Therefore, undr this optimal policy, the relative quality z_t will fluctuate between two fixed bounds, $z_{max} = 1$ and $z_{min} = e^{-\lambda\varepsilon}$, decreasing continuously over each interval. Correspondingly, the price set by the domestic firm will fluctuate between $p(1) = w^N$ and $p(e^{-\lambda\varepsilon}) = w^N e^{-\lambda\varepsilon}$, with operating profits

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[10] μ_t is the shadow price of relaxing the quality constraint, $q_t \le e^{\lambda t_t}$, and is always positive. If $\lambda > \rho$, the positive impact of delaying adjustment on the relaxation of the quality constraint $\mu_t \lambda e^{\lambda t_t}$ more than offsets the reduction induced on the discount factor, $-\mu_t \rho e^{\lambda t_t}$, and $\mu_t(\lambda - \rho)e^{\lambda t_t} > 0$.

fluctuating between $F(1) = s_s\left[1 - w / w^N\right]$ and $F(e^{-\mu}) = s_s\left[1 - w / w^N e^{-\mu}\right]$ (See Figure 2). This ongoing price competition between Southern and Northern firms will have a positive effect on growth. The consumption index $D(t)$ will be continuously increasing over time because of the decline of prices within each interval, and because of the quality adjustments between intervals.[11] The competitive pressure from the Northern producers will thus lead to a constant and positive rate of growth.

Let us now consider the implications of implementing tariffs on the imports of foreign produced differentiated goods. A tariff will raise the limit price: domestic firms can price now at the foreign producer's marginal cost adjusted for relative quality and for the tariff, i.e.,

(14) $$p_t(z_t, 1+\delta_t) = w^N(1+\delta_t)z_t,$$

where δ_t is an ad-valorem tariff. Tariffs will thus have a positive impact on operating profits at each point in time,

(15) $$F[z_t(1+\delta_t)] = s_s\left[1 - \frac{w}{z_t w^N(1+\delta_t)}\right], \qquad \frac{\partial F(.)}{\partial(1+\delta_t)} > 0$$

What will be the effect on the policy for quality adjustment? Tariffs will increase the wedge between the tariff adjusted foreign and domestic marginal costs of production, thereby allowing domestic firms to extend the length of the period without imitation. In particular, a sequence of tariffs $\{1+\delta_t\}$ such that $(1+\delta_t) \geq w / z_t w^N$, would allow the domestic the firm to postpone adjustment indefinitely, by isolating domestic prices from the widening quality gap. On the other hand, a permanent fixed tariff would allow the Southern firm to postpone the quality adjustments, but not indefinitely, since domestic prices would still decline continuously in response to the widening quality gap in each interval. Finally, tariffs will have a negative impact on consumers'

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[11] The growth rate of the consumption index is given by $\hat{D}(t) = d_t \log D(t) = ds_s \int_0^1 \log[q_t(j)x_t(j)]dj = s_s\lambda$.

welfare, through higher quality-adjusted prices. Recall that only workers consume, and that their incomes are not affected by the tariffs. To determine the effect of tariffs on consumers' instantaneous utility, let us derive the indirect utility function for the workers/consumers, by substituting in (2') for the equilibrium $x(j)$, to get:

$$(19)\ \log D(1+\delta_t) = s_x \log\left[\frac{s_x}{w^N e^{-\lambda t}(1+\delta_t)}\right] + (1-s_x)\log\left[\frac{(1-s_x)}{p_x}\right]. \qquad \frac{\partial \log D(1+\delta_t)}{\partial(1+\delta_t)} = -\frac{s_x}{(1+\delta_t)} < 0$$

where $\log D(1+\delta_t)$, the indirect utility function of worker consumers depends only on $(1+\delta_t)$, because nominal expenditure is constant, and has been set equal to one.

3. Endogenous Tariff Cycles:

I now consider the implications of the availability of a political market for import tariffs. Each firm will act as a profit maximizer, and will lobby for its own tariff, since the other firms' tariffs will not affect its profits, given that wages are fixed. The problem is symmetric to all firms, and I can thus focus on the behavior of a representative firm. The equilibrium tariff will result from a contribution game between the firm and the government, a dynamic analogue of Grossman and Helpman (1994).[12] At each point in time the firm will determine for different tariff levels the profits that it will obtain and the contributions that the government will request, and choose the optimal tariff.[13] The government will require contributions that offset the weight it attaches to the impact of equilibrium tariffs on its social welfare function. The firm will seek tariffs that dampen the effect of a growing quality gap on operating profits, allowing it to postpone adjustment. However, the required contributions are likely to be growing as the quality gap widens, eroding the

[12] The lobbying process is modelled in a similar fashion by Brainard and Verdier (1994).
[13] Tariffs are lobbied upon continuously to avoid problems of time consistency. If the government and the firm negotiated a permanent tariff or a sequence of tariffs at time zero, it would pay to the government to implement the tariff, and then to eliminate it once it has collected the contribution.

benefits from lobbying without adjusting. Therefore, it is in order to inquire if the firm will choose to lobby for a sequence of tariffs that allow it to delay imitation indefinitely, or if it will prefer to adjust at regular intervals. It is also necessary to determine if the firm will lobby for protection at all the levels of the quality gap, or only after a certain threshold has been reached.

The main results of this section can be briefly summarized. There will be cycles in protection. The optimal policy for the domestic firm will be to lobby for a sequence of tariffs that exactly offset the negative effects of a widening quality gap on prices and profits. However, since the campaign contributions required by the government will be growing with the size of the tariffs, the firm will not be able to delay adjustment indefinitely. It will still be optimal to imitate foreign quality at intervals of constant duration, and to lobby for a lower tariff, or to cease lobbying, when quality is adjusted. When political preferences for contributions are relatively low, there will occur a full liberalization, and free trade will last for a finite sub-interval of constant duration. During these "good times" the consumption index will be growing by virtue of the decline in domestic prices. However, once the quality gap has reached a certain threshold, it will be more profitable to start lobbying again, until the next quality adjustment, when a new liberalization will ensue. When the preferences for contributions are relatively high, the firm will never cease to lobby. At the time of the adjustment, the tariff will fall, but will remain positive. There will thus be a partial liberalization, with tariffs starting to grow again immediately thereafter, until the next imitation. In this case, the "good times" will last just one period, when the quality adjustment occurs.

The firm's problem will now be to define an optimal policy for imitation, the tariffs that it will demand, the contributions that it will pay, and whether it will lobby during the entire interval between quality adjustments, or during only part of it. The firm will first solve the policies for quality adjustment and for the initiation of lobbying as a function of the equilibrium tariffs and contributions. Then it will engage in a contribution game with the government, in which both follow Markovian strategies. At each point in time the firm will choose simultaneously the level of the quality gap and the contribution, and the government will then choose the tariff it will grant. The firm will then take the resulting equilibrium tariffs and contributions and determine the optimal timing of the quality adjustment and of the initiation of lobbying.

The firm will solve its dynamic optimization problem in the following fashion. Suppose at $t_0 = 0$ the firm plans to adjust its quality at the points of time $0 \leq t_1 < t_2 < t_3 < \ldots < t_\tau < \ldots$. Denote the fixed domestic quality in the interval $[t_\tau, t_{\tau+1})$ by q_τ. Further suppose that the firm plans to lobby during all or part of each interval between quality adjustments, starting at the points of time $T_0 \leq T_1 < T_2 < T_3 < \ldots < T_\tau < \ldots$, $T_\tau \in [t_\tau, t_{\tau+1}]$. Denote the tariffs within the interval by $(1 + \delta_{t-t_\tau})$. The profits during this interval are given by:

$$(20) \quad \int_{t_\tau}^{T_\tau} F[q_\tau e^{-\lambda t}]e^{-rt}dt + \int_{T_\tau}^{t_{\tau+1}} F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})]e^{-rt}dt - \beta e^{-rt_{\tau+1}} - \int_{T_\tau}^{t_{\tau+1}} g(1+\delta_{t-t_\tau})e^{-rt}dt$$

where $g(1 + \delta_{t-t_\tau})$ are the variable costs of lobbying, or the schedule of campaign contributions to the government as a function of the tariff. The first term corresponds to the profits attained during the initial phase at which no protection is granted, quality is held constant, and prices are falling in response to the increasing quality gap. The second term represents the profits during the subsequent phase at which there is active lobbying resulting in positive tariffs, quality is held constant, and the behavior of prices depends on the size of the tariff with respect to the quality gap. Finally, the third term corresponds to the contributions that the firm has to pay to the government to secure positive tariffs during the phase of active lobbying.

Long run profits are obtained by summing (20) over τ:

$$(21) \quad V_0 = \sum_{\tau=0}^{\infty}\left[\int_{t_\tau}^{T_\tau} F[q_\tau e^{-\lambda t}]e^{-rt}dt + \int_{T_\tau}^{t_{\tau+1}} F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})]e^{-rt}dt - \beta e^{-rt_{\tau+1}} - \int_{T_\tau}^{t_{\tau+1}} g(1+\delta_{t-t_\tau})e^{-rt}dt\right]$$

where initial quality is assumed to be $q_0 = 1$, and $t_0 = 0$. The firm's objective will be to choose sequences $\{t_\tau\}, \{T_\tau\}, \{q_\tau\}, \{1+\delta_{\tau, t_\tau}\}, \tau = 1, 2, \ldots$ that maximize V_0, subject to $q_\tau \leq e^{\lambda t_\tau}$. The solution to this problem is presented in Appendix B. Again, it will be optimal for the domestic firm to catch up to the latest foreign quality at the time of the adjustment, since profits always increase in domestic quality, and the costs of imitation are independent of the size of the quality gap. Thus,

$$(11') \qquad q_\tau = e^{\lambda t_\tau}$$

The firm will again define a sequence of intervals $\{t_{\tau+1} - t_\tau\}$ during which domestic quality will be held constant, followed by catch-ups to foreign quality. The length of these intervals will be determined by the first order condition with respect to t_τ,

$$(22) \qquad F[q_\tau e^{-\lambda t_\tau}] - F[q_{\tau-1} e^{-\lambda t_\tau}(1+\delta_{t_\tau - t_{\tau-1}})] + g(1+\delta_{t_\tau - t_{\tau-1}}) - \rho\beta = \mu_\tau(\lambda - \rho)e^{\lambda t_\tau}$$

which states that the gains from postponing a quality adjustment, given by the net profits just before the imitation, $F[q_{\tau-1} e^{-\lambda t_\tau}(1+\delta_{t_\tau - t_{\tau-1}})] - g(1+\delta_{t_\tau - t_{\tau-1}})$, the interest saved on the adjustment costs, $\rho\beta$, plus the impact of increasing t_τ on the present discounted value of the marginal return from relaxing the quality constraint, $\mu_\tau(\lambda - \rho)e^{\lambda t_\tau}$, must be equal to the loss from the postponement, given by the profits just after the adjustment, $F[q_\tau e^{-\lambda t_\tau}]$.

The firm will also have to decide on whether it is going to lobby for protection during part ($T_\tau > 0$), all ($T_\tau = t_{\tau+1} - t_\tau$), or no part ($T_\tau = 0$), of the interval without adjustment, depending on the net benefits from lobbying relative to profits under free trade at all levels of the quality gap. The firm will thus define a sequence of sub-intervals during which it does not lobby and free trade prevails, the duration of which will be determined by the first order condition with respect to T_τ,

$$(23) \qquad F[q_\tau e^{-\lambda T_\tau}] - F[q_\tau e^{-\lambda T_\tau}(1+\delta_{T_\tau - t_\tau})] + g(1+\delta_{T_\tau - t_\tau}) = 0$$

which states that the loss from switching to lobbying , given by the profits just before the switch, $F[q, e^{-\lambda T_i}]$, must be equal to the gain, given by the profits just after the switch $F[q, e^{-\lambda T_i}(1+\delta_{T_i-t_i})] - g(1+\delta_{T_i-t_i})$.

From (22) and (23) it emerges that both the length of the intervals between adjustments and of the sub-intervals where free trade prevails will be a function of the tariffs and the contribution schedules that result from the political equilibrium of the contribution game between the firm and the government. Intuitively, higher tariffs will increase the wedge between the minimum price that a foreign producer can charge and domestic wages, inducing a faster switch to lobbying and a postponement of quality adjustments. However, higher tariffs are likely to be met by higher contributions, which would prompt a faster adjustment. Therefore, it is now in order to determine the equilibrium tariffs and contributions that will arise from the contribution game.

I will assume, as in Brainard and Verdier (1994), that at each point in time the firm first chooses the level of the quality gap and the contribution schedule simultaneously, and that the politician then selects a tariff that maximizes its own welfare function. I assume that they both follow Markovian strategies. I assume that the government's objective function is given by

$$(24) \qquad \Omega_0 = \sum_{i=0}^{\infty}\left[\int_{t_i}^{t_{i+1}} \log D(1+\delta_{t-t_i})e^{-rt}dt + a\int_{t_i}^{t_{i+1}} g(1+\delta_{t-t_i})e^{-rt}dt\right]$$

The government cares about the long run welfare of consumers (the first term between brackets), and about the campaign contributions, weighted by a parameter a that measures the political preferences for contributions (the last term). The government's welfare function should in principle include a concern for the value of the firm. The restrictive specification used here is introduced only for simplifying the analysis, and it does not qualitatively affect the results.[14] With this

[14] The reduced forms for the equilibrium tariffs will not qualitatively change if I introduce the value of the firm in the government's welfare function, assume that the entrepreneurs consume at home, or if the ownership of the firms is smoothly distributed, since firms act as profit maximizers. However, the effects

structure of moves in the contribution game and the Markovian strategies, the government's choice of tariffs affects only the contemporaneous levels of the contribution and of the quality gap. Therefore, the politician's optimization over the tariff choice will yield the following first order conditions:

$$(25) \qquad \frac{\partial \log D(1+\delta_{t-t_\tau})}{\partial(1+\delta_{t-t_\tau})} = ag'(1+\delta_{t-t_\tau})$$

The government will require contributions that compensate in the margin the welfare changes arising from the implementation of the tariff.[15] Given the relationship between tariffs and contributions arising from this condition, the firm will maximize the value of the firm, V_0 (as defined by (21)), by its choice of the contribution level and of the quality gap at each point in time. Taking the quality gap as given, the first order condition with respect to $(1+\delta_{t-t_\tau})$ is:

$$(26) \qquad \frac{\partial F[q_t e^{-\lambda t}(1+\delta_{t-t_\tau})]}{\partial(1+\delta_{t-t_\tau})} = g'(1+\delta_{t-t_\tau})$$

The firm will choose its contribution schedule such that the marginal benefits from derived from the tariffs equal the marginal costs of protection derived in (25).[16] This contribution will have to be such that it compensates on the margin the marginal changes in the government welfare function generated by the tariff. Taken together, the government and the firm's first order conditions result in the following equilibrium tariffs:

$$(27) \qquad (1+\delta_{t-t_\tau}) = \frac{awe^{\lambda(t-t_\tau)}}{w^N} \qquad\qquad t \in [t_\tau, t_{\tau+1})$$

---

of changes in the underlying parameters on the lengths of the interval between adjustments and of the free trade phase will be harder to sign.

[15] This condition in turn guarantees that the contributions paid for granting the tariffs, weighted by the government's preferences for contributions, compensate in the long-run the cumulative welfare changes derived from the tariffs.

[16] This condition is called "local truthfulness" by Grossman and Helpman (1994). It means that each lobby will set its contribution schedule so that the marginal change in the contribution in response to a small change in the tariff is equal to the effect of the tariff change on the lobby's gross profits.

The equilibrium tariffs will increase with the quality gap during each interval, with the political preference for campaign contributions, and will decrease with domestic competitiveness, w^N / w. Therefore, the firm will lobby for tariffs that insulates prices and profits from increases in the quality gap, and from losses of competitiveness. The sequence of equilibrium tariffs will additionally be such that in the long-run the cumulative increases in profits accrued to the tariffs will be equal to the cumulative changes welfare due to the tariffs, weighted the preferences for contributions.

Having determined the equilibrium tariffs, it is now in order to determine the lobbying contribution schedule, which is derived by integrating (25) over $(1+\delta_{t-t_i})$,

$$(28) \qquad g(1+\delta_{t-t_i}) = \int_1^{1+\delta_{t-t_i}} g'(1+\delta_{t-t_i})d(1+\delta_{t-t_i}) = \frac{s_x}{a}\log(1+\delta_{t-t_i})$$

The contributions required by the government will increase with the size of the tariff and with the share of nominal expenditure allocated to differentiated goods, s_x, and will decline with the political preference for firms' profits.

It is now possible to determine the lengths of the intervals without protection and without adjustment. Regarding the former, the firm may find that for initially low levels of the quality gap it is not profitable to lobby for protection. This could be the case if the required contributions were too high as a result of low preferences for contributions, rendering the net benefits from lobbying lower than the operating profits attained under free trade at all levels of the quality gap. However, as the quality gap becomes larger, reducing the operating profits, it may become profitable to start lobbying at some point in time. Now, let us recall that, from (23), the firm's optimal policy will be to start lobbying at the point in time when the profits attained just before starting to lobby equal the net benefits from lobbying at that level of the quality gap. In Appendices B and C it is shown that substituting into (23) for the optimal $\{q_t\}$ and $\{1+\delta_{T_i-t_i}\}$ from (11') and (27), and for the contribution schedule from (28), the length of the sub-interval during which the firm does not lobby, $\{T_i - t_i\}$, denoted by ε_0, will be unique, and implicitly defined by:

$$(29) \qquad \frac{1}{a} - \frac{w e^{\lambda \varepsilon_0}}{w^N} + \frac{1}{a} \log\left[\frac{a w e^{\lambda \varepsilon_0}}{w^N}\right] = 0$$

By total differentiation of (29) it can be shown that $d\varepsilon_0 / da < 0$, $d\varepsilon_0 / d(w/w^N) < 0$, $d\varepsilon_0 / d\lambda < 0$. Bigger preferences for firms' profits lead to higher equilibrium tariffs and net benefits from lobbying, and to a faster the abandonment of free trade. Lower competitiveness yields lower profits under free trade, and induces and earlier beginning of lobbying. A higher the rate of growth of foreign quality results in lower profits both under free trade and under lobbying, but the first effect prevails, leading to a shorter free trade period. It may be the case that the preferences for contributions, and the ensuing net benefits from lobbying, are high enough as to make it profitable to lobby at all points in time, even at the point when the firm has adjusted domestic quality. By making $\varepsilon_0 = 0$ in (29), the minimum a at which permanent lobby will be profitable will be implicitly defined by:

$$(30) \qquad \frac{1}{a} - \frac{w}{w^N} + \frac{1}{a} \log\left[\frac{a w}{w^N}\right] = 0$$

This minimum a is such that the operating profits at the time of the quality adjustment are equal to the net benefits from lobbying at that point. Decreases in a would lead to some temporary free trade, while increases in a would raise the profitability of permanent lobbying.

The next matter of interest is to determine the length of the intervals between quality adjustments. Will the firm be able to postpone adjustment indefinitely? Or will it be forced to imitate at periodic intervals, reducing the lobbying effort at the time of the adjustment and leading to an "endogenous liberalization" through a discrete fall in the equilibrium tariff? Two cases will have to be distinguished in the analysis. First, the case in which preferences for contributions are "low", and an initial period of temporary free trade attains. Second, the case in which preferences for contributions are "high", and it pays to lobby permanently. In the first case, $\varepsilon_o > 0$, and the loss from postponing the adjustment will be given by the operating profits under free trade for a nil quality gap, $F[q_r e^{-\lambda t_i}]$. The length of the interval will be determined by substituting into (22), the first order condition for $\{t_i\}$, by the optimal $\{q_i\}$ and $\{1+\delta_{T_i - t_i}\}$ from (11') and (27), and by the contribution schedule from (28). In Appendices B and C it is shown that the length of this interval, $\{t_{i+1} - t_i\}$, denoted by ε, will be unique, and implicitly defined by:

$$(31) \qquad \frac{1}{a} - \frac{\rho\beta}{s_x} + \frac{1}{a}\log\left[\frac{awe^{\lambda t}}{w^N}\right] = \frac{w}{w^N}e^{(\lambda-\rho)\varepsilon_o} + \frac{(\lambda-\rho)}{a\rho}\left[e^{-\rho\varepsilon_o} - e^{-\rho\varepsilon}\right]$$

The length of this interval will increase with the preferences for contributions. An increase in a will increase the net benefits from lobbying through higher tariffs, and lower contributions, prompting to postpone adjustment.[17] Imitation would be indefinitely postponed only when a tends to infinity, making the lobbying contributions go to zero, and the net benefits from lobbying without adjusting exceed those from adjusting and liberalizing at all levels of the quality gap. However, in general, for finite values of the preferences for contributions, the firm will find it optimal to imitate at intervals of constant and finite duration. Additionally, the interval between adjustments will increase with β, and it will decrease with increases in λ, save when λ is too small with respect to ρ.[18] Changes in competitiveness will have an ambiguous effect.[19]

[17] When $(\lambda - \rho)$ is negative, the increase in a will increase the present discounted value of the marginal return of relaxing the quality constraint, reinforcing the incentive to delay adjustment. When $(\lambda - \rho)$ is positive, the inverse will happen, but as long as λ is not too large with respect to ρ the positive effect of a higher a on the net benefits from lobbying will still prevail, and imitation will be postponed.

[18] An increase in λ will reduce the net benefits from lobbying, prompting a faster adjustment. Additionally, it will increase the positive effect of delaying adjustment on the present discounted value of the marginal return of relaxing the quality constraint when $\lambda > \rho$. If the inverse happens, but λ is not too small with respect to ρ, the first effect would still prevail.

The firm will lobby during part of the period without adjustment; following the initial phase of free trade after the imitation, a level of the quality gap will be reached at which the net benefits from lobbying will exceed those from free trade, and the firm will lobby for protection until the next quality adjustment, when a liberalization will attain. The duration of this sub-interval, $\{t_{i+1} - T_i\}$, denoted by $\varepsilon_c = \varepsilon - \varepsilon_o$, will also be unique, and implicitly defined by:

$$(32) \qquad \frac{1}{a} - \frac{\rho\beta}{s_x} + \frac{1}{a}\log\left[\frac{awe^{\lambda(\varepsilon_o+\varepsilon_c)}}{w^N}\right] = \frac{w}{w^N}e^{(\lambda-\rho)\varepsilon_o} + \frac{(\lambda-\rho)}{a\rho}\left[e^{-\rho\varepsilon_o} - e^{-\rho(\varepsilon_o+\varepsilon_c)}\right]$$

As shown in the Appendix B, $d\varepsilon_c / da > 0$, for most parameter values. Higher preferences for contributions will increase the length of the protectionist phase, as the higher net benefits from lobbying lead to a faster abandonment of free trade and to a postponement of the quality adjustment. Additionally, the length of this phase will increase with the cost of imitation, while changes in competitiveness and in foreign quality growth will have ambiguous effects.

When the preferences for contributions are "high," as determined by (30), the firm will never stop lobbying, and the first order condition for $\{t_i\}$ must be modified to reflect the fact that the loss from postponing adjustment will now be given by the net benefits from lobbying when the quality gap is nil, $F[q_t e^{-\lambda t_i}(1+\delta_0)] - g(1+\delta_0)$:

$$(22') \qquad F[q_t e^{-\lambda t_i}(1+\delta_0)] - F[q_{t-1} e^{-\lambda t_i}(1+\delta_{t_i - t_{i-1}})] - g(1+\delta_0) + g(1+\delta_{t_i - t_{i-1}}) - \rho\beta = \mu_t(\lambda-\rho)e^{\lambda t_i}$$

Again, the length of the interval without adjustment, denoted by ε, will be unique, and implicitly defined by:

$$(33) \qquad \frac{\lambda\varepsilon}{a} - \frac{\rho\beta}{s_x} = \frac{(\lambda-\rho)}{a\rho}\left[1 - e^{-\rho\varepsilon}\right]$$

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[19] A loss of competitiveness will decrease both the profits after the adjustment and the net benefits from lobbying before the adjustment, and will increase the positive impact of a delay in imitation on the shadow value of the quality constraint. The net effect is ambiguous.

As in the previous case, an increase in the political preference for campaign contributions will induce to postpone the adjustment and the switching to lower tariffs, except when λ is too large with respect to ρ. An increase in β will increase the gains from postponing adjustment. Changes in λ will have an ambiguous effect, as they will both decrease the net benefits from lobbying before the adjustment, and increase the positive impact of a delay in the imitation on the shadow value of the quality constraint. Changes in competitiveness will not affect the length of the protectionist cycle because they will have the same impact on the costs of lobbying both at the beginning and at the end of each interval. They will not affect operating profits, as the equilibrium tariffs will offset any loss of competitiveness. See Appendix B.

Therefore, given the optimal policies for quality imitation, the relative quality will fluctuate between two fixed bounds, $z_{max} = 1$ and $z_{min} = e^{-\lambda t}$, decreasing continuously over each interval, and jumping upward at the time of the imitation. In the case of permanent lobbying, tariffs will grow continuously between two fixed bounds, $1+\delta_0 = aw / w^N$ and $1+\delta_t = awe^{\lambda t} / w^N$, jumping downward when imitation attains. As a result, the domestic prices and the ensuing profits will remain constant over time: $p(1) = p(e^{-\lambda t}) = aw$, and $F(1) = F(e^{-\lambda t}) = s_t[1-1/a]$. See Figure 4. In the case of complete liberalization and temporary free trade, tariffs will be zero, ($1+\delta_0 = 1$), until the time of switching to lobbying, then experience a discrete upward jump, ($1+\delta_{t_0} = awe^{\lambda t_0} / w^N$), growing continuously thereafter until the next quality adjustment, ($1+\delta_t = awe^{\lambda t} / w^N$). Prices will remain constant under lobbying, $p(e^{-\lambda t_0}) = p(e^{-\lambda t}) = aw$, suffering a discrete fall at the time of imitation and liberalization, $p(1) = w^N$, and declining continuously thereafter, until the new protectionist phase starts. Likewise, operating profits will be constant during the protectionist episode, $F(e^{-\lambda t_0}) = F(e^{-\lambda t}) = s_t[1-1/a]$, jumping downward at the time of the adjustment, $F(1) = s_x\left[1 - w / w^X\right]$, and declining continuously until lobbying restarts. See Figure 5. The equilibrium tariffs will thus be such that they will exactly offset the increases in the quality gap, keeping prices and profits constant. The need for adjustment will arise from the increase in the campaign contributions required as the quality gap and the ensuing equilibrium tariffs increase over time. See Figures 4 and 5.

Regarding the growth effects of the optimal lobbying and adjustment strategies, two cases must be distinguished. First, when there is initial free trade, the growth of the consumption index will be positive during this initial phase, as domestic prices decline in response to the widening quality gap. Growth will be nil during the protectionist phase, as tariffs offset the widening quality gap. Finally, the consumption index will experience a discrete increase at the time of the quality adjustment.

$$(34) \qquad d\log D(1+\delta_t) = \begin{cases} s_x\lambda, \forall t \in [t_\tau, T_\tau) \\ 0, \forall t \in [T_\tau, t_{\tau+1}) \\ s_x\left[\lambda\varepsilon + \log\left[aw / w^X\right]\right], \forall t = t_{\tau+1} \end{cases}$$

Second, when permanent lobbying is optimal, the growth of the consumption index will be nil during the interval without adjustment, as tariffs will insulate domestic prices from the widening quality gap. However, it will experience discrete jumps at the time of the imitation.

$$(35) \qquad d\log D(1+\delta_t) = \begin{cases} ds_x \log\left[s_x e^{\lambda t_\tau} / aw\right] = 0, \forall t \in [t_\tau, t_{\tau+1}) \\ s_x \log\left[s_x e^{\lambda t_{\tau+1}} / aw\right] - s_x \log\left[s_x e^{\lambda t_\tau} / aw\right] = s_x\lambda\varepsilon, \forall t = t_{\tau+1} \end{cases}$$

4. Some conclusions and extensions:

The model shows that if a market for endogenous protections is made available, firms that must undergo costly adjustments to keep up with the quality or technology upgrading by foreign producers will find it optimal to lobby for a sequence of tariffs that insulate domestic prices and profits from foreign competitive pressure, allowing to postpone adjustment. Such a behavior would lead to persistent protection, and to a widening quality or technology gap, as observed in the experience of many developing countries. However, if the government is factoring in the social welfare losses from endogenous protection it will require increasing lobbying efforts to maintain protection, and a point may be reached in which domestic firms will prefer to adjust and to allow for a trade liberalization. If the government cares a lot about the lobbying groups, the liberalization will likely be partial, with tariffs immediately ressuming a non declining path. If the government has a low concern for the lobbyists' profits, a full liberalization is likely to attain, followed by a phase of free trade and positive growth. However, these subsequent "good times" of free trade would last only until the increase in the competitive pressure from foreign producers has made it possible to engage in an effective lobbying effort again.

The model presented here offers some interesting insights about the dynamics of trade policies in developing countries. The previous episodes of transitory trade liberalization reported by Sachs and Warner (1995) fit nicely into the predictions of the model. They suggest that lower preferences for lobbyists' welfare led to protectionist cycles of shorter duration and to temporary free trade in these countries. As the model would predict, these nations experienced lackluster growth before the liberalization and after the reversal, and high growth during the open period. The main reasons cited for the reversal to protectionism, namely political and ideological shifts, are also consistent with the mechanisms presented in this model. The results are also consistent with the observed links between closed trade policies and technological backwardness, and with the observed increases in productivity following large liberalizations. Regarding the recent liberalizations en masse, the model would explain the simultaneity of these liberalizations only if all these countries had been politically and technologically similar. As this is highly unlikely, it is more reasonable to pressume that the debt crisis of the early 1980s probably operated as a big negative shock to preferences for lobbyists welfare, abruptly shortening the protectionist cycle across developing nations. However, the partial reversals in the recent trade liberalizations reported by the IMF can be explained by the model as the beginning of a new protectionist cycle in countries where the political preferences for lobbyists' profits and/or production costs are relatively high.

One interesting extension to the analysis done here would be to allow wages to fluctuate, thus introducing a motivation for an strategic interaction among firms, and to allow firms to form coalitions. Another scenario worth studying is one in which the high-tech firms produce import-competing intermediate inputs, and in which the other domestic productive sectors that demand these inputs lobby against protection. These extensions may yield different results regarding the time path of trade policies and regarding the time horizon of trade liberalization.

Appendix A

The firm's objective will be to choose sequences $\{t_\tau\}$, $\{q_\tau\}$, $\tau = 1, 2, \ldots$ that maximize

$V_0 = \sum_{\tau=0}^{\infty}\left[\int_{t_\tau}^{t_{\tau+1}} F[q_\tau e^{-\lambda t}]e^{-\rho t}dt - \beta e^{-\rho t_{\tau+1}}\right]$ where initial quality is assumed to be $q_0 = 1$, and $t_0 = 0$,

subject to $q_\tau \le e^{\lambda t_\tau}$.[1] The Lagrangean for this problem is:

$$\text{A.1} \qquad \Im = \sum_{\tau=0}^{\infty}\left[\int_{t_\tau}^{t_{\tau+1}} F[q_\tau e^{-\lambda t}]e^{-\rho t}dt - \beta e^{-\rho t_{\tau+1}} + \mu_\tau e^{-\rho t}[e^{\lambda t_\tau} - q_\tau]\right]$$

The first order conditions for the optimization over $\{q_\tau\}$ and $\{t_\tau\}$ are:

$$\text{A.2} \qquad \int_{t_\tau}^{t_{\tau+1}} \frac{\partial F[q_\tau e^{-\lambda t}]}{\partial q_\tau} e^{-\rho t}dt = \mu_\tau e^{-\rho t_\tau}$$

$$\text{A.3} \qquad F[q_\tau e^{-\lambda t_\tau}] - F[q_{\tau-1}e^{-\lambda t_\tau}] - \rho\beta = \mu_\tau(\lambda - \rho)e^{\lambda t_\tau}$$

$$\text{A.4} \qquad \mu_\tau \ge 0 \qquad\qquad e^{\lambda t_\tau} - q_\tau \ge 0 \qquad\qquad \mu_\tau\left[e^{\lambda t_\tau} - q_\tau\right] = 0$$

Determination of $\{q_\tau\}$: Equation A.2 and the fact that $F'(z) > 0$ for all z imply that $\mu > 0$ (the firm would be better off if it could adjust quality beyond the foreign quality level). This condition and the slack condition, equation A.4 in turn imply that

$$\text{A.5} \qquad q_\tau = e^{\lambda t_\tau}$$

Determination of $\{t_\tau\}$: The first order condition for $\{t_\tau\}$, equation A.3, can be reexpressed, substituting for μ_τ from A.2, and for the optimal $\{q_\tau\}$ from A.5 as

$$\text{A.6} \qquad e^{\lambda(t_\tau - t_{\tau-1})} - e^{(\lambda-\rho)(t_{\tau+1}-t_\tau)} = \frac{w^N}{s_x w}\rho\beta$$

Uniqueness of $t_\tau - t_{\tau-1}$: The problem faced by the domestic monopolist here is very similar to the one analyzed by Sheshinski and Weiss (1977). As in their case, for any solution $\{t_\tau^*\},\{q_\tau^*\},\{1+\delta_{t-t_\tau}^*\}$, there exists a unique ε such that $t_{\tau+1}^* = t_\tau^* + \varepsilon$ and $q_{\tau+1}^* = q_\tau^* e^{\lambda\varepsilon}$.

Proof. As in Sheshinski and Weiss (1977), by the principle of optimality, if $\{t_\tau^*\},\{q_\tau^*\}$, maximize V_0, they also maximize the present discounted value of profits at t_1^*, t_2^*,..., and so on, denoted by V_1, V_2,.... Specifically,

$$\text{A.7} \qquad V_1 = \sum_{\tau=1}^{\infty}\left[\int_{t_\tau}^{t_{\tau+1}} F(q_\tau e^{-\lambda t})e^{-\rho(t-t_1^*)}dt - \beta e^{-\rho(t_{\tau+1}-t_1^*)}\right]$$

[1] Note that $\arg\max_z F(z) = 1$. Therefore, to ensure that $V_0 \ge 0$ at the optimum, the adjustment costs must be small relative to $F(1)$.

A.8 $$V_2 = \sum_{\tau=2}^{\infty} \left[\int_{t_\tau}^{t_{\tau+1}} F(q_\tau e^{-\lambda t}) e^{-\rho(t-t_2^*)} dt - \beta e^{-\rho(t_{\tau+1}-t_2^*)} \right]$$

A.9 $$V_2 = \sum_{\tau=1}^{\infty} \left[\int_{t_\tau}^{t_{\tau+1}} F(q_{\tau+1} e^{-\lambda t}) e^{-\rho(t-t_2^*)} dt - \beta e^{-\rho(t_{\tau+2}-t_2^*)} \right]$$

Using the transformation $u = t - t_1^*$, rewrite A.7

A.10 $$V_1 = \sum_{\tau=1}^{\infty} \left[\int_{t_\tau - t_1^*}^{t_{\tau+1}-t_1^*} F(q_\tau e^{-\lambda t_1^*} e^{-\lambda u}) e^{-\rho u} du - \beta e^{-\rho(t_{\tau+1}-t_1^*)} \right]$$

Similarly, using $u = t - t_2^*$, rewrite A.9 as

A.11 $$V_2 = \sum_{\tau=1}^{\infty} \left[\int_{t_{\tau+1} - t_2^*}^{t_{\tau+2}-t_2^*} F(q_{\tau+1} e^{-\lambda t_2^*} e^{-\lambda u}) e^{-\rho u} du - \beta e^{-\rho(t_{\tau+2}-t_2^*)} \right]$$

The variables to be determined in V_1 are

$\{t_\tau - t_1^*\} = \{0, t_2 - t_1^*, t_3 - t_1^*, \ldots\}$, and $\{q_\tau e^{-\lambda t_1^*}\} = \{q_1^* e^{-\lambda t_1^*}, q_2 e^{-\lambda t_1^*}, \ldots\}$

In V_2, the variables to be determined are:

$\{t_{\tau+1} - t_2^*\} = \{0, t_3 - t_2^*, t_4 - t_2^*, \ldots\}$, and $\{q_{\tau+1} e^{-\lambda t_2^*}\} = \{q_2^* e^{-\lambda t_2^*}, q_3 e^{-\lambda t_2^*}, \ldots\}$

The functions V_1 and V_2 are identical in the corresponding variables. Hence,

$t_2^* - t_1^* = t_3^* - t_2^* = \ldots = \varepsilon$ and

$q_1^* e^{-\lambda t_1^*} = q_2^* e^{-\lambda t_2^*} = \ldots$ or $q_2^* = q_1^* e^{\lambda(t_2^* - t_1^*)} = q_1^* e^{\lambda\varepsilon}$

Therefore, we can reexpress A.5 as:

A.12 $$e^{\lambda\varepsilon} - e^{(\lambda-\rho)\varepsilon} = \frac{w^N}{s_x w}\rho\beta$$

The effects of changes in wage differentials, in adjustment costs, and in foreign quality growth are respectively given by:

A.8 $$\frac{\partial\varepsilon}{\partial(w^N / w)} = \frac{e^{-\lambda\varepsilon}\rho\beta}{s_x[\lambda(1-e^{-\rho\varepsilon}) + \rho e^{-\rho\varepsilon}]} > 0, \quad \frac{\partial\varepsilon}{\partial\beta} = \frac{e^{-\lambda\varepsilon}\rho w^N}{s_x w[\lambda(1-e^{-\rho\varepsilon}) + \rho e^{-\rho\varepsilon}]} > 0,$$

$$\frac{d\varepsilon}{d\lambda} = \frac{\varepsilon[e^{-\rho\varepsilon} - 1]}{[\lambda(1-e^{-\rho\varepsilon}) + \rho e^{-\rho\varepsilon}]} < 0$$

Appendix B

The firm's objective will be to choose sequences $\{t_\tau\}$, $\{T_\tau\}$, $\{q_\tau\}$, $\{1+\delta_{t-t_\tau}\}$ $\tau = 1, 2, \ldots$ that maximize

$$V_0 = \sum_{\tau=0}^{\infty}\left[\int_{t_\tau}^{T_\tau} F[q_\tau e^{-\lambda t}]e^{-\rho t}dt + \int_{T_\tau}^{t_{\tau+1}} F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})]e^{-\rho t}dt - \beta e^{-\rho t_{\tau+1}} - \int_{T_\tau}^{t_{\tau+1}} g(1+\delta_{t-t_\tau})e^{-\rho t}dt\right]$$

where initial quality is assumed to be $q_0 = 1$, and $t_0 = 0$, subject to $q_\tau \leq e^{\lambda t_\tau}$. The first order conditions for the optimization over $\{q_\tau\}$, $\{t_\tau\}$, $\{T_\tau\}$, and $\{1+\delta_{t-t_\tau}\}$ are:

B.1 $$\int_{t_\tau}^{T_\tau}\frac{\partial F[q_\tau e^{-\lambda t}]}{\partial q_\tau}e^{-\rho t}dt + \int_{T_\tau}^{t_{\tau+1}}\frac{\partial F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})]}{\partial q_\tau}e^{-\rho t}dt = \mu_\tau e^{-\rho t_\tau}$$

B.2 $$F[q_\tau e^{-\lambda t_\tau}] - F[q_{\tau-1}e^{-\lambda t_\tau}(1+\delta_{t_\tau - t_{\tau-1}})] + g(1+\delta_{t_\tau - t_{\tau-1}}) - \rho\beta = \mu_\tau(\lambda-\rho)e^{\lambda t_\tau}$$

B.3 $$F[q_\tau e^{-\lambda T_\tau}] - F[q_\tau e^{-\lambda T_\tau}(1+\delta_{T_\tau - t_\tau})] + g(1+\delta_{T_\tau - t_\tau}) = 0$$

B.4 $$\mu_\tau \geq 0 \qquad e^{\lambda t_\tau} - q_\tau \geq 0 \qquad \mu_\tau\left[e^{\lambda t_\tau} - q_\tau\right] = 0$$

B.5 $$\frac{\partial F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})]}{\partial(1+\delta_{t-t_\tau})} = g'(1+\delta_{t-t_\tau})$$

Determination of $\{q_\tau\}$: As before, the marginal return from relaxing the quality constraint will be positive, and hence, from B.1 and B.4,

B.6 $$q_\tau = e^{\lambda t_\tau}$$

Determination of $\{T_\tau\}$: The first order condition for $\{T_\tau\}$, equation B.3, can be reexpressed, substituting for the optimal $\{q_\tau\}$ from B.6, for the equilibrium $\{1+\delta_{t-t_\tau}\}$ from (27) in the text, and for the contribution schedule from (28) in the text, as

B.7 $$s_x\left[1 - \frac{we^{\lambda(T_\tau - t_\tau)}}{w^N}\right] = s_x\left[1-\frac{1}{a}\right] - \frac{s_x}{a}\log\left[\frac{awe^{\lambda(T_\tau - t_\tau)}}{w^N}\right]$$

The length of the sub-interval during which free trade prevails, $\{T_\tau - t_\tau\}$, will be unique (shown in Appendix C), and will be implicitly determined by equation B.7. A graphical determination of the duration of this subinterval is presented in Figure 2. Denoting this subinterval by ε_o, we can now rewrite B.7 as:

B.8 $$\frac{1}{a} - \frac{we^{\lambda\varepsilon_o}}{w^N} + \frac{1}{a}\log\left[\frac{awe^{\lambda\varepsilon_o}}{w^N}\right] = 0$$

The length of this subinterval will decrease with the preferences for contributions, with a loss of competitiveness, and with the rate of growth of foreign quality:

B.9 $\dfrac{d\varepsilon_0}{da} = \dfrac{\log\left[\dfrac{awe^{\lambda\varepsilon_0}}{w^N}\right]}{a^2\lambda\left[\dfrac{1}{a} - \dfrac{we^{\lambda\varepsilon_0}}{w^N}\right]} < 0$, $\quad \dfrac{d\varepsilon_0}{d\left[\dfrac{w}{w^N}\right]} = \dfrac{\left[e^{\lambda\varepsilon_0} - \dfrac{w^N}{aw}\right]}{\lambda\left[\dfrac{1}{a} - \dfrac{we^{\lambda\varepsilon_0}}{w^N}\right]} < 0$, $\quad \dfrac{d\varepsilon_0}{d\lambda} = -\dfrac{\varepsilon_o}{\lambda} < 0$

Determination of $\{t_t\}$: The first order condition for $\{t_t\}$, equation B.2, can be reexpressed, substituting for μ_t from B.1, for the optimal $\{q_t\}$ from B.6, for the equilibrium $\{1+\delta_{t,t_t}\}$ from (27), and for the contribution schedule from (28), as

$$\text{B.10} \qquad \frac{1}{a} - \frac{\rho\beta}{s_x} + \frac{1}{a}\log\left[\frac{awe^{\lambda(t_t - t_{t-1})}}{w^N}\right] = \frac{w}{w^N}e^{(\lambda-\rho)(T_t - t_t)} + \frac{(\lambda-\rho)}{a\rho}\left[e^{-\rho(T_t - t_t)} - e^{-\rho(t_{t+1} - t_t)}\right]$$

The length of the interval during between imitations, $\{T_t - t_t\}$, will be unique (shown in Appendix C), and will be implicitly determined by equation B.10. Denoting this subinterval by ε, we can now rewrite B.10 as:

$$\text{B.11} \qquad \frac{1}{a} - \frac{\rho\beta}{s_x} + \frac{1}{a}\log\left[\frac{awe^{\lambda\varepsilon}}{w^N}\right] = \frac{w}{w^N}e^{(\lambda-\rho)\varepsilon_o} + \frac{(\lambda-\rho)}{a\rho}\left[e^{-\rho\varepsilon_o} - e^{-\rho\varepsilon}\right]$$

Since both ε and ε_o will be unique, the length of the subinterval during which lobbying prevails, denoted by $\varepsilon_c = \{t_{t+1} - T_t\}$, will also be unique, and implicitly defined by

$$\text{B.12} \qquad \frac{1}{a} - \frac{\rho\beta}{s_x} + \frac{1}{a}\log\left[\frac{awe^{\lambda(\varepsilon_o+\varepsilon_c)}}{w^N}\right] = \frac{w}{w^N}e^{(\lambda-\rho)\varepsilon_o} + \frac{(\lambda-\rho)}{a\rho}\left[e^{-\rho\varepsilon_o} - e^{-\rho(\varepsilon_o+\varepsilon_c)}\right]$$

A sufficient condition for the lengths of the interval without adjustment and of the protectionist phase to increase with the preferences for contributions is that $\rho \geq \lambda$.

$$\text{B.13} \qquad \frac{d\varepsilon}{da} = \frac{1}{a}\left\{\log\left[\frac{awe^{\lambda\varepsilon}}{w^N}\right] - \frac{(\lambda-\rho)e^{-\rho\varepsilon_o}}{\lambda}\log\left[\frac{awe^{\lambda\varepsilon_o}}{w^N}\right] - \frac{(\lambda-\rho)}{\rho}\left[e^{-\rho\varepsilon_o} - e^{-\rho\varepsilon}\right]\right\}\text{H}$$

$$\text{B.14} \qquad \frac{d\varepsilon_c}{da} = a\left\{\left[(\lambda-\rho)e^{-\rho\varepsilon_o}\left[\frac{we^{\lambda\varepsilon_o}}{w^N} - \frac{1}{a}(1-e^{-\rho\varepsilon_c})\right] - \frac{\lambda}{a}\right]\frac{d\varepsilon_o}{da} + \frac{1}{a^2}\left[\log\left[\frac{awe^{\lambda\varepsilon}}{w^N}\right] - \frac{(\lambda-\rho)}{\rho}\left[e^{-\rho\varepsilon_o} - e^{-\rho\varepsilon}\right]\right]\right\}\text{H}$$

where $\text{H} = \left[\lambda(1-e^{-\rho\varepsilon}) + \rho e^{-\rho\varepsilon}\right]^{-1} > 0$. Both equations will be positive if

$(\lambda-\rho) < \log\left[\dfrac{awe^{\lambda\varepsilon}}{w^N}\right]\left\{\dfrac{e^{-\rho\varepsilon_o}}{\lambda}\log\left[\dfrac{awe^{\lambda\varepsilon_o}}{w^N}\right] + \dfrac{1}{\rho}\left[e^{-\rho\varepsilon_o} - e^{-\rho\varepsilon}\right]\right\}^{-1} > 0$; nil or negative otherwise.

The length of the interval without adjustment will increase with the cost of adjustment. Changes in competitiveness will have an ambiguous effect. A sufficient condition for increases in the rate of foreign quality growth to accelerate adjustment will be that $\lambda \geq \rho$.

B.15 $\dfrac{d\varepsilon}{d\beta} = \dfrac{a\rho}{s_x}\text{H} > 0$, $\qquad \dfrac{d\varepsilon}{d\left[w/w^N\right]} = a\left\{e^{(\lambda-\rho)\varepsilon_o} - \dfrac{w^N}{aw} - (\lambda-\rho)e^{-\rho\varepsilon_o}\left[e^{\lambda\varepsilon_o} - \dfrac{w^N}{aw}\right]\right\}\text{H}$: ambiguous sign

$$\frac{d\varepsilon}{d\lambda}=a\left\{\frac{1}{a\rho}\left[e^{-\rho t_o}-e^{-\rho t}-\varepsilon\right]-(\lambda-\rho)e^{-\rho t_o}\left[\frac{w}{w^N}e^{\lambda t_o}-\frac{1}{a}\right]\frac{\varepsilon_o}{\lambda}\right\}H<0,\qquad \text{if } (\lambda-\rho)>K\text{ ; where}$$

$$K=\lambda e^{\rho t_o}\left[e^{-\rho\varepsilon_o}-e^{-\rho t_o}-\varepsilon\right]/a\rho\varepsilon_o\left[\frac{we^{\lambda t_o}}{w^N}-\frac{1}{a}\right]<0\text{ ; nil or positive otherwise.}$$

The duration of the protectionist phase, ε_c, will increase with the cost of adjustment (since $d\varepsilon_o/d\beta=0$ and $d\varepsilon/d\beta>0$). Changes in competitiveness and in the rate of foreign quality growth will have an ambiguous effect.

$$\frac{d\varepsilon_c}{d(w/w^N)}=a\left\{\left[(\lambda-\rho)e^{-\rho t_o}\left[\frac{we^{\lambda t_o}}{w^N}-\frac{1}{a}(1-e^{-\rho\varepsilon_c})\right]-\frac{\lambda}{a}\right]\frac{d\varepsilon_o}{d(w/w^N)}+\left[e^{(\lambda-\rho)t_o}-\frac{w^N}{aw}\right]\right\}H\text{ : ambiguous sign}$$

$$\frac{d\varepsilon_c}{d\lambda}=a\left\{\frac{w\rho}{w^N\lambda}\varepsilon_o e^{(\lambda-\rho)t_o}+\frac{\lambda(1-\rho)+\rho^2}{a\lambda\rho}\left[1-e^{-\rho\varepsilon_c}\right]-\frac{\varepsilon}{a}\right\}H\text{ : ambiguous sign}$$

Determination of $\{t_\tau\}$ when permanent lobbying is optimal: The first order conditions for $\{q_\tau\}$ and $\{t_\tau\}$, must be reexpressed as

B.1' $$\int_{t_\tau}^{t_{\tau+1}}\frac{\partial F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})]}{\partial q_\tau}e^{-\rho t}dt=\mu_\tau e^{-\rho t_\tau}$$

B.2' $$F[q_\tau e^{-\lambda t_\tau}(1+\delta_0)]-F[q_{\tau-1}e^{-\lambda t_\tau}(1+\delta_{t_\tau-t_{\tau-1}})]-g(1+\delta_0)+g(1+\delta_{t_\tau-t_{\tau-1}})-\rho\beta=\mu_\tau(\lambda-\rho)e^{\lambda t}\ ,$$

B.2' can be reexpressed, substituting for μ_τ from B.1', for the optimal $\{q_\tau\}$ from B.6, for the equilibrium $\{1+\delta_{t-t_\tau}\}$ from (27), and for the contribution schedule from (28), as

B.16 $$\frac{\lambda}{a}(t_\tau-t_{\tau-1})-\frac{\rho\beta}{s_x}=\frac{(\lambda-\rho)}{a\rho}\left[1-e^{-\rho(t_{\tau+1}-t_\tau)}\right]$$

Equation B.16 implicitly defines the length of the interval without adjustment when permanent lobbying is optimal. Also in this case, applying the principle of optimality, the duration of this interval will constant, and I can thus reexpress B.16 as

B.17 $$\frac{\lambda}{a}\varepsilon-\frac{\rho\beta}{s_x}=\frac{(\lambda-\rho)}{a\rho}\left[1-e^{-\rho\varepsilon}\right]$$

When lobbying is permanent, the duration of the interval between quality adjustments will increase with the cost of adjustment. A sufficient condition for the length of the interval without adjustment to increase with the preferences for contributions is that $\rho\geq\lambda$. Changes in foreign quality growth will have an ambiguous effect.

$$\frac{d\varepsilon}{da}=\frac{1}{a}\left\{\lambda\varepsilon-\frac{(\lambda-\rho)}{\rho}\left[1-e^{-\rho\varepsilon}\right]\right\}H>0\text{, if } (\lambda-\rho)<\frac{\rho\lambda\varepsilon}{\left[1-e^{-\rho\varepsilon}\right]}>0\text{ ; nil or negative otherwise.}$$

$$\frac{d\varepsilon}{d\beta}=\frac{a\rho}{s_x}H>0\qquad\qquad \frac{d\varepsilon}{d\lambda}=\left[\frac{1}{\rho}[1-e^{-\rho\varepsilon}]-\varepsilon\right]H\text{ : ambiguous sign, where H is as above.}$$

Appendix C

Uniqueness of $\{T_\tau - t_\tau\}, \{t_{\tau+1} - t_\tau\}$: The problem faced by the domestic monopolist here is very similar to the one analyzed in Appendix I. In this case, , for any solution $\{t_\tau^*\},\{T_\tau^*\},\{q_\tau^*\},\{1+\delta^*_{t-t_\tau}\}$, there also exists a unique pair ε_o , ε such that $T_\tau^* = t_\tau^* + \varepsilon_o$, $t^*_{\tau+1} = t^*_\tau + \varepsilon$ and $q^*_{\tau+1} = q^*_\tau e^{\lambda\varepsilon}$.

Proof. As in Sheshinski and Weiss (1977), by the principle of optimality, if $\{t_\tau^*\},\{T_\tau^*\},\{q_\tau^*\},\{1+\delta^*_{t-t_\tau}\}$, maximize V_0, they also maximize the present discounted value of profits at t_1^*, t_2^*,.... and so on, denoted by V_1, V_2,.... Specifically,

$$\text{C.1}\quad V_1 = \sum_{\tau=1}^{\infty}\left[\int_{t_\tau}^{T_\tau} F[q_\tau e^{-\lambda t}]e^{-\rho(t-t_1^*)}dt + \int_{T_\tau}^{t_{\tau+1}} F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})]e^{-\rho(t-t_1^*)}dt - \beta e^{-\rho(t_{\tau+1}-t_1^*)} - \int_{T_\tau}^{t_{\tau+1}} g(1+\delta_{t-t_\tau})]e^{-\rho(t-t_1^*)}dt\right]$$

$$\text{C.2}\quad V_2 = \sum_{\tau=2}^{\infty}\left[\int_{t_\tau}^{T_\tau} F[q_\tau e^{-\lambda t}]e^{-\rho(t-t_2^*)}dt + \int_{T_\tau}^{t_{\tau+1}} F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})]e^{-\rho(t-t_2^*)}dt - \beta e^{-\rho(t_{\tau+1}-t_2^*)} - \int_{T_\tau}^{t_{\tau+1}} g(1+\delta_{t-t_\tau})]e^{-\rho(t-t_2^*)}dt\right]$$

$$\text{C.3}\quad V_2 = \sum_{\tau=1}^{\infty}\left[\int_{t_{\tau+1}}^{T_{\tau+1}} F[q_{\tau+1} e^{-\lambda t}]e^{-\rho(t-t_2^*)}dt + \int_{T_{\tau+1}}^{t_{\tau+2}} F[q_{\tau+1} e^{-\lambda t}(1+\delta_{t-t_{\tau+1}})]e^{-\rho(t-t_2^*)}dt - \beta e^{-\rho(t_{\tau+2}-t_2^*)} - \int_{T_{\tau+1}}^{t_{\tau+2}} g(1+\delta_{t-t_{\tau+1}})]e^{-\rho(t-t_2^*)}dt\right]$$

Using the transformation u = t - t_1^*, rewrite C.1 as:

$$V_1 = \sum_{\tau=1}^{\infty}\left[\int_{t_\tau-t_1^*}^{T_\tau-t_1^*} F[q_\tau e^{-\lambda t_1^*}e^{-\lambda u}]e^{-\rho u}du + \int_{T_\tau-t_1^*}^{t_{\tau+1}-t_1^*} F[q_\tau e^{-\lambda t_1^*}e^{-\lambda u}(1+\delta_{u+t_1^*-t_\tau})]e^{-\rho u}du - \beta e^{-\rho(t_{\tau+1}-t_1^*)} - \int_{T_\tau-t_1^*}^{t_{\tau+1}-t_1^*} g(1+\delta_{u+t_1^*-t_\tau})]e^{-\rho u}du\right]$$

Similarly, using u = t - t_2^*, rewrite C.3 as:

$$V_2 = \sum_{\tau=1}^{\infty}\left[\int_{t_{\tau+1}-t_2^*}^{T_{\tau+1}-t_2^*} F[q_{\tau+1} e^{-\lambda t_2^*}e^{-\lambda u}]e^{-\rho u}du + \int_{T_{\tau+1}-t_2^*}^{t_{\tau+2}-t_2^*} F[q_{\tau+1} e^{-\lambda t_2^*}e^{-\lambda u}(1+\delta_{u+t_2^*-t_{\tau+1}})]e^{-\rho u}du - \beta e^{-\rho(t_{\tau+2}-t_2^*)} - \int_{T_{\tau+1}-t_2^*}^{t_{\tau+2}-t_2^*} g(1+\delta_{u+t_2^*-t_{\tau+1}})]e^{-\rho u}du\right]$$

The variables to be determined in V_1 are

$\{t_\tau - t_1^*\} = \{0, t_2 - t_1^*, t_3 - t_1^*, \ldots.\}$, $\qquad \{T_\tau - t_1^*\} = \{T_1 - t_1^*, T_2 - t_1^*, T_3 - t_1^*, \ldots.\}$,

$\{q_\tau e^{-\lambda t_1^*}\} = \{q_1^* e^{-\lambda t_1^*}, q_2 e^{-\lambda t_1^*}, \ldots\}$, and $\quad \{1+\delta_{u+t_1^*-t_\tau}\} = \{1+\delta_u, 1+\delta_{u+t_1^*-t_2}, 1+\delta_{u+t_1^*-t_3}, \ldots.\}$

In V_2, the variables to be determined are:

$\{t_{\tau+1} - t_2^*\} = \{0, t_3 - t_2^*, t_4 - t_2^*, \ldots.\}$, $\qquad \{T_{\tau+1} - t_2^*\} = \{T_2 - t_2^*, T_3 - t_2^*, T_4 - t_2^*, \ldots.\}$

$\{q_{\tau+1} e^{-\lambda t_2^*}\} = \{q_2^* e^{-\lambda t_2^*}, q_3 e^{-\lambda t_2^*}, \ldots\}$, and $\quad \{1+\delta_{u+t_2^*-t_{\tau+1}}\} = \{1+\delta_u, 1+\delta_{u+t_2^*-t_3}, 1+\delta_{u+t_2^*-t_4}, \ldots.\}$

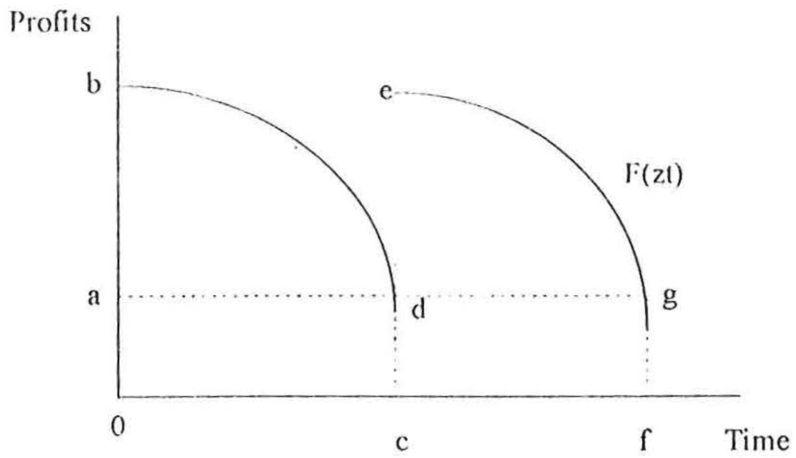
The functions V_1 and V_2 are identical in the corresponding variables. Hence,

$t_2^* - t_1^* = t_3^* - t_2^* = \ldots. = \varepsilon \qquad$ and $\qquad T_1^* - t_1^* = T_2^* - t_2^* = \ldots. = \varepsilon_o$

$q_1^* e^{-\lambda t_1^*} = q_2^* e^{-\lambda t_2^*} = \ldots. \qquad$ or $\qquad q_2^* = q_1^* e^{\lambda(t_2^*-t_1^*)} = q_1^* e^{\lambda\varepsilon}$

and $\quad 1+\delta_{u+t_1^*-t_2^*} = 1+\delta_{u+t_2^*-t_3^*} = \ldots. = 1+\delta_{u-\varepsilon}$

Figure 2



where,

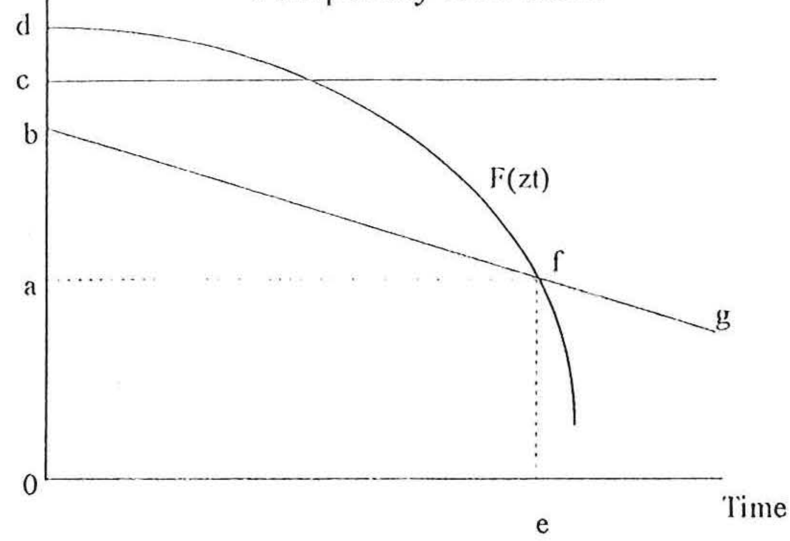
$0b = ce = F(1)$

$0a = cd = F(e^{-\lambda\varepsilon})$

$0c = cf = \varepsilon$

Figure 3

Temporary free trade



0d = Profits under free trade, when catching-up: $F(1)$

0c = Profits under equilibrium tariffs, before contributions: $F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})] = s_x[1-1/a]$

bg = Net benefits from lobbying, under equilibrium tariffs:

$F[q_\tau e^{-\lambda t}(1+\delta_{t-t_\tau})] - g(1+\delta_{t-t_\tau}) = s_x[1-1/a] - (s_x/a)\log[awe^{\lambda(t-t_\tau)}/w^N]$

bc = Equilibrium contribution, when catching-up: $g(1+\delta_0) = (s_x/a)\log[aw/w^N]$

0b = Net benefits from lobbying, when catching-up:

$F[q_\tau e^{-\lambda t}(1+\delta_0)] - g(1+\delta_0) = s_x[1-1/a] - (s_x/a)\log[aw/w^N]$

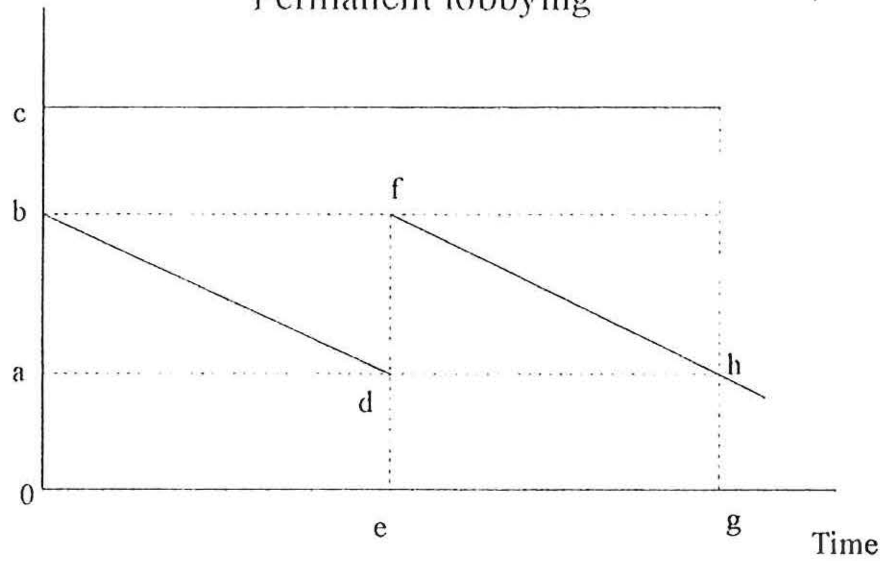
0a = Profits at the time of initiating lobbying:

$F[q_\tau e^{-\lambda\varepsilon_0}] = F[q_\tau e^{-\lambda\varepsilon_0}(1+\delta_{\varepsilon_0})] - g(1+\delta_{\varepsilon_0})$

0e = Length of free trade phase: ε_0

Figure 4

Permanent lobbying



0c = Profits under equilibrium tariffs, before contributions:

$$F[q_t e^{-\lambda t}(1+\delta_{t-t_i})] = s_x[1-1/a] = F(1) = F(e^{-\lambda\varepsilon})$$

bd = Net benefits from lobbying, under equilibrium tariffs:

$$F[q_t e^{-\lambda t}(1+\delta_{t-t_i})] - g(1+\delta_{t-t_i}) = s_x[1-1/a] - (s_x/a)\log[awe^{\lambda(t-t_i)}/w^N]$$

bc = Equilibrium contribution, when catching-up: $g(1+\delta_0) = (s_x/a)\log[aw/w^N]$

0b = ef = Net benefits from lobbying, when catching-up:

$$F[q_t e^{-\lambda t}(1+\delta_0)] - g(1+\delta_0) = s_x[1-1/a] - (s_x/a)\log[aw/w^N]$$

0a = ed = Profits at the point in time before catching-up:

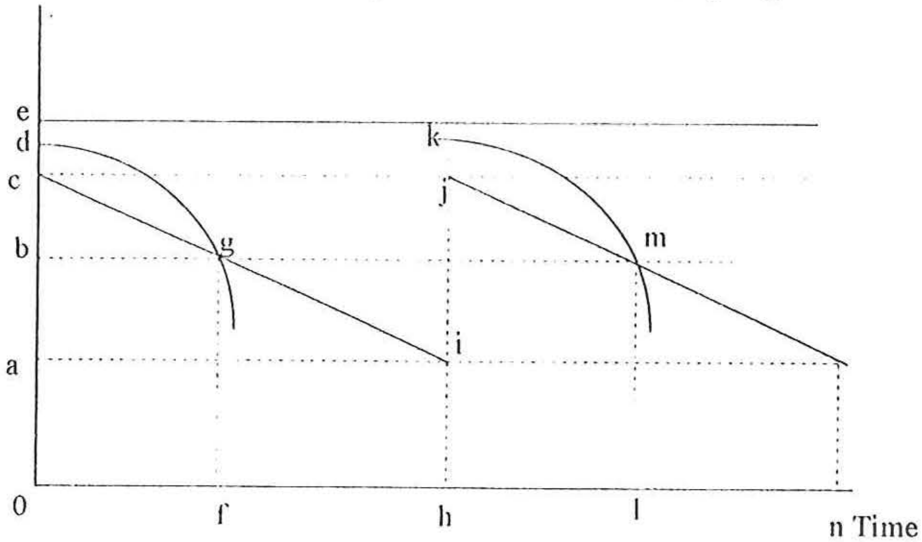
$$F[q_t e^{-\lambda\varepsilon}(1+\delta_\varepsilon)] - g(1+\delta_\varepsilon) = s_x[1-1/a] - (s_x/a)\log[awe^{\lambda\varepsilon}/w^N]$$

df = Interest saved on the cost of adjustment, plus marginal return from relaxing the quality constraint: $\rho\beta + \mu_t(\lambda-\rho)e^{\lambda t_i}$

0e = eg = Length of the interval between adjustments: ε

Figure 5

Alternating free trade and lobbying



0d = Profits under equilibrium tariffs, before contributions:

$F[q_t e^{-\lambda t}(1+\delta_{t-t_t})] = s_x[1 - 1/a]$

ci = Net benefits from lobbying, under equilibrium tariffs:

$F[q_t e^{-\lambda t}(1+\delta_{t-t_t})] - g(1+\delta_{t-t_t}) = s_x[1 - 1/a] - (s_x/a)\log[awe^{\lambda(t-t_t)}/w^N]$

cd = Equilibrium contribution, when catching-up: $g(1+\delta_0) = (s_x/a)\log[aw/w^N]$

0e = hk = Profits under free trade, when catching-up: $F(1) = s_x[1 - w/w^N]$

fg = lm = Profits at the time of initiating lobbying:

$F[q_t e^{-\lambda\varepsilon_0}] = F[q_t e^{-\lambda\varepsilon_0}(1+\delta_{\varepsilon_0})] - g(1+\delta_{\varepsilon_0})$

hi = Profits at the point in time before catching-up:

$F[q_t e^{-\lambda\varepsilon}(1+\delta_\varepsilon)] - g(1+\delta_\varepsilon) = s_x[1 - 1/a] - (s_x/a)\log[awe^{\lambda\varepsilon}/w^N]$

ik = Interest saved on the cost of adjustment, plus marginal return from relaxing the quality constraint: $\rho\beta + \mu_t(\lambda - \rho)e^{\lambda t_t}$

0h = hn = Length of the interval between adjustments: ε

0f = hl = Length of the free trade phase: ε_o

fh = ln = Length of the protectionist phase: ε_t

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