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WAS ALEXANDER HAMILTON RIGHT ?
Limit-pricing foreign monopoly and
infant-industry protection

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Working Paper No. 55

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ABSTRACT

In 1791, Alexander Hamilton put forward an argument for infant-industry protection based on the need to overcome the entry-deterring behaviour of foreign monopolists. This paper recasts Hamilton's argument as a model of strategic trade policy under asymmetric information, and examines the credibility and time-consistency of such protection, and the intertemporal welfare trade-offs it involves. It finds that while Hamilton's prescription is valid for a particular case, it is not robust, and the optimal policy might instead involve a commitment *not* to protect the domestic industry.

1. INTRODUCTION

The ancestry of the infant-industry argument for protection is usually traced to Alexander Hamilton's Report on Manufactures, submitted to the Congress of the United States in 1791. The received wisdom is that Hamilton's case rested on what today would be called dynamic increasing returns to scale, but this begged the question of why the infant industry could not finance its early losses by borrowing against its own future profits. If imperfect capital markets are to blame, then government intervention should be targeted to redress this problem, rather than protecting the industry with tariffs that impose a by-product consumption distortion, do not provide any incentive for the "infant" to grow up, and whose eventual removal may prove difficult.

Standing aside from this debate, I take for my starting point in this paper a very different argument for infant-industry protection, buried in an obscure passage of Hamilton's Report:

Combinations by those engaged in a particular branch of business in one country, to frustrate the first efforts to introduce it into another, by temporary sacrifices, recompensed perhaps by extraordinary indemnifications of the government of such country, are believed to have existed, and are not to be regarded as destitute of probability. The existence or assurance of aid from the government of the country, in which the business is to be introduced, may be essential to fortify adventurers against the dread of such combinations, to defeat their effects, if formed and to prevent their being formed, by demonstrating that they must in the end prove fruitless. (Quoted in Stegeman, 1989, p.85).

Shorn of its archaic phrasing, and translated into the language of modern economics, this inchoate model of strategic behaviour is nearly two centuries ahead of its time. Hamilton is arguing that infant-industry protection serves to overcome limit-pricing of exports, by which foreign monopolies ("combinations") deter entry by home-country firms. Moreover, anticipated assistance from the home-country government precludes this behaviour and promotes entry. This is quite independent of any scale economies or capital market imperfections.

While Hamilton might thus be regarded as the founder of strategic trade policy (STP), his formulation is open to several objections from the modern theorist. First, the foreign firm may not in fact find it profitable to maintain the limit price if entry does occur. The maintenance of the pre-entry output level after entry (an assumption known as the "Sylos postulate" in the industrial organization literature) is a non-credible threat which will not deceive a rational entrant. Second, the government may not find it optimal to impose the promised tariff after entry. Hamilton, of course, was interested in promoting the industrialization of the young American republic and asserting its economic independence. He was not using the welfare function of the late twentieth-century economist, but any contemporary restatement of his argument must take into account the consumption distortion and possibly inefficient entry resulting from a tariff.

Third, even if protection-induced entry can be justified on rent-shifting grounds, the foreign firm will anticipate it--as Hamilton correctly noted--and not sacrifice profits by limit-pricing. But this deprives the importing country of a terms-of-trade gain. In assessing the case for protection, this must be set off against whatever gains accrue from entry and rent-shifting. Indeed Brander and Spencer (1981), in the first of their many papers on STP, argued for a tariff on a limit-pricing foreign monopolist on very different grounds. They had the monopolist behaving as a Stackelberg leader against the potential entrant, supplying a quantity just high enough (price just low enough) to make entry unprofitable. A tariff would be wholly absorbed by the monopolist with zero pass-through into prices, and thus successfully extract rent without any loss of consumers' surplus. They conceded, however, in response to a referee's comment, that the credibility of such behaviour by the incumbent was open to question (Brander and Spencer, 1981, p.385).

The gaps in Hamilton's argument, as also in Brander and Spencer, raise issues of credibility, time-consistency, and intertemporal trade-offs, and call for the modern reformulation attempted in this paper. It is by now universally recognized that the pre-entry price has no effect on post-entry profits, and hence on the entry decision, unless some kind of commitment mechanism is explicitly modelled, or unless the price signals some private information to the entrant which affects his calculation of the profitability of entering. It is this second modification--introduced into the literature by Milgrom and Roberts (1982; hereafter

MR)--that is used here. This amounts to "rationalizing" Brander and Spencer in a more acceptable theoretical framework by "internationalizing" Milgrom and Roberts. This fills a gap in the STP literature, which is confined to either static market structures or models with free entry. The optimal policy response to entry-detering behaviour by foreign firms has not been modelled since Brander and Spencer's flawed attempt. More generally, the model analyzes strategic trade policy in a setting which seems most relevant to late-industrializing developing countries. It can thus be seen as a response to the challenge issued by Levy and Nolan (1992) to relocate the STP debate in the traditional development economics terrain of infant industry protection, rather than static rent-shifting. In this respect, the structure of the model (a single incumbent facing a single potential entrant) somewhat resembles that of Dixit and Kyle (1985). They, however, were explicitly concerned with competition in high-technology products between firms in developed countries ("Boeing-Airbus rivalry") in each other's markets under full information, no entry-detering behaviour at the level of the firms, and with only two extreme trade policy options, free trade and autarky.

This paper also continues the more recent trend in the STP literature, in that it incorporates asymmetric cost information and considers the time-consistency of interventionist trade policies. These issues have been extensively analyzed in respect of export policy,¹ as well as protection of established firms that are supposed to undertake cost-reducing investment or technology adoption, faced with competitively-supplied imports.² The few papers that address these two issues in the context of foreign market power in the domestic market have a different orientation from mine. In Hartigan (1994), a foreign firm engages in predatory dumping to signal low costs and induce the exit of an established domestic rival. In Kolev and Prusa (1997), a foreign monopolist with private cost information raises its price to signal higher costs and elicit a lower tariff. I introduce a tension between this and the need to signal lower costs to deter entry.

¹ See Qiu (1994), Collie and Hviid (1993), and Brainard and Martimort (1997) for models with private cost information; Goldberg (1995), Karp and Perloff (1995), Leahy and Neary (1996) and other papers cited there for time-consistency issues.

² Miyagiwa and Ohno (1995) and Wright (1995) examine the time-consistency of tariffs to protect an existing domestic monopolist.

The next section modifies the MR model in various ways in order to deal with these issues. Sections 3 and 4 then derive trade-policy results when post-entry competition is Bertrand and Cournot, respectively. Section 5 concludes.

2. THE MODEL

A foreign firm, as a result of historical first-mover advantages (or a patent that is about to expire), has acquired incumbency in a developing-country market. Its constant unit costs are known only to itself, but are commonly known to be drawn from a distribution which takes values c^H and c^L with probabilities h and $1-h$ respectively. Alternatively, the exporter's cost might be known to be c^H , but the home government might suspect that with probability $1-h$ it is receiving an export subsidy (Hamilton's "extraordinary indemnifications") of $c^H - c^L$. Since such subsidies are prohibited by the GATT, they cannot be given overtly, and must be signalled through lower prices.³ Finally, the incumbent is constrained to supplying the home market from abroad, ruling out tariff-jumping direct foreign investment, which has been analyzed in the context of full-information strategic tariffs by Levy and Nolan (1992) and Horstmann and Markusen (1992).

The domestic firm is modelled as a potential entrant, whose unit costs c^e are assumed common knowledge. This "one-sided" information asymmetry is the version of the MR model presented in Fudenberg and Tirole (1989, 308-11), and highlights the issues raised in the Introduction without unnecessary algebraic complications. The entrant can guarantee itself zero profit by staying out, but must sink an entry cost of K (also common knowledge) to commence production. Potential foreign entrants are assumed to have higher entry costs than the domestic firm, attributable to lack of familiarity with the local market, which can accommodate at most one new entrant. The only entrant the incumbent need be concerned with is thus the domestic firm.

³ Such pricing behaviour cannot be adduced as evidence of subsidization before a GATT panel. Nor can it be caught by anti-dumping provisions in the absence of injury to a domestic firm, which does not yet exist.

Demand parameters are common knowledge. Inevitably, I assume linear inverse demand: $P=a-(x+y)$, where x and y are the sales of the domestic and foreign firms respectively, and $a > c^H > c^L$. Demand and cost parameters are such that under free trade, the entrant would expect to make losses net of entry costs (and therefore stay out) if the incumbent were known for certain to be low-cost. If the incumbent's costs were known to be high, the entrant's duopoly profits would at least cover the entry cost, and he would enter. Denote the profit of a type i ($= H, L$) incumbent as M^i in any period in which she is a monopolist, and D^i whenever she is a duopolist. The entrant's duopoly operating profit (gross of entry costs K) when confronting a type i incumbent is denoted π^i . Thus,

$$\pi^H \geq K > \pi^L \geq 0 \quad (1)$$

The model has a two-period structure. The incumbent learns her cost level from "Nature" and chooses an export level in period 1. Observing this, the entrant updates his assessment of the incumbent's costs and decides whether to enter on the basis of his expected profits. Then, in period 2, costs become common knowledge and, if entry occurs, duopolistic competition (Cournot or Bertrand) ensues. Otherwise, the incumbent produces her monopoly output. The government imposes a per-unit tariff in each period, before the firms' quantity decisions are made. I consider alternative scenarios where the period 2 tariff is either committed in advance or re-optimized after the cost information is signalled and the entry decision is made. Both the incumbent and the government weight their period 2 payoffs (profits and welfare, respectively) by a factor of δ . I allow for $\delta > 1$ to permit period 2 to be much longer than period 1, so that payoffs can be larger even after discounting.

I look at separating equilibria,⁴ in which each type of incumbent chooses a different first-period quantity, enabling the entrant to infer the type precisely and make an "informed" decision based on the updated posterior probability of 0 or 1. Entry then takes place exactly when it would under symmetric information, but the type L incumbent is

⁴ Welfare analysis of the pooling equilibrium of the MR model proves to be algebraically intractable when the components of welfare are made functions of tariff levels. A simple way of ruling out a pooling equilibrium is to assume that the prior h is always high enough to induce entry.

obliged to incur a first-period sacrifice to signal its costs by charging a limit price P_L so low that the high-cost type incumbent would not find it profitable to do so, even if it deterred entry. This price credibly signals low costs, the entrant updates his assessment to $h=0$, and stays out. The incentive-compatibility condition for a type i incumbent to choose such a limit price in period 1, rather than its monopoly price, is

$$M^i(P_L) + \delta M^i \geq M^i + \delta D^i \quad (2)$$

The possible separating prices are those for which (2) is satisfied for the low-cost type but not for the high-cost type. Many values of P_L satisfy the separating condition, but standard refinements leave a unique "least cost" separating equilibrium, where the latter constraint is "just" violated. In practice, it is obtained as the price at which (2) holds with equality for type H. By construction, lower prices which deter entry are dominated for this type by its monopoly price, even if entry is thereby accommodated. The entrant's posterior inference upon observing such prices can only be $h=0$, and the L type incumbent need not uselessly sacrifice first-period profits by charging anything less than this "least-cost" separating price. (2) continues to be satisfied for type L at this price, since it is less of a sacrifice for that type to undertake a given price reduction. The H type can do no better than charge its static monopoly price and accommodate entry.

The effects of tariff protection: The rent-shifting role of tariffs is supplemented in this paper by their ability to enhance the profitability of entry, raising π^L in (1) sufficiently to exceed K , so the entrant is not deterred by its rival's low costs. This could also be achieved by a production or investment subsidy. Obviously, a combination of the three policies would be optimal to promote entry and shift rents. However, as argued in recent strategic trade literature,⁵ raising the revenue to finance subsidies is costly. Instead of incorporating a parameter representing the social cost of public funds, I consider only a tariff. Call this entry-promoting period 2 tariff t_e .⁶ This will be compared with tariffs that

⁵ Neary (1994), Bhattacharjea (1995), Brainard and Martimort (1997).

⁶ A tariff in period 1 can also reverse (2), making limit pricing unprofitable even if it deters entry. This does not occur in the Bertrand case, or for the parameter values used to illustrate the Cournot case.

maximize single-period welfare, defined as the unweighted sum of consumer surplus, tariff revenue and domestic profits. For the functional forms assumed here, this is:

$$W \equiv \frac{(x+y)^2}{2} + ty + (P-c^e)x - K \quad (3)$$

Two straightforward optimal tariff results are stated here as lemmas which will prove useful below:

Lemma 1: The optimal tariff on a foreign monopolist of type i that is maximizing single-period profits is $t^i = (a-c^i)/3$, and this is unchanged when there is a domestic rival in Cournot duopoly.⁷

Lemma 2: If the monopolist's type is unknown, the tariff that maximizes single-period expected welfare is simply based on expected costs: $\bar{t} = (a - Ec)/3$, where $Ec \equiv hc^H + (1-h)c^L$.⁸

3. POST-ENTRY BERTRAND DUOPOLY

Bertrand duopoly with homogeneous products yields very simple pure-strategy equilibria, with the lower-cost firm capturing the entire market by pricing just below the cost of its higher-cost rival.⁹ This may seem to be extremely simplistic, but these corner solutions make for algebraic tractability, which is otherwise difficult to achieve in the MR model. Stiglitz (1987) and Sutton (1989) have shown that interesting results can be obtained by embedding this duopoly outcome in a multi-stage framework. In the present context, resolving ties with equal prices in favour of the entrant, he will capture the entire market with a price of $c^i + t_2$, provided this weakly exceeds his own cost level. The entrant therefore perceives demand as:

⁷ This was first proved by Kabiraj (1993) for homogeneous products and by Bhattacharjea (1995) for differentiated products.

⁸ This is easily proved from the expression from expected welfare; see also Kolev and Prusa (1997).

⁹ This is also sometimes described as "limit pricing". However, I reserve this term for the signalling behaviour described in the preceding section.

$$x = \begin{cases} a - c^i - t_2 & \text{for } c^i + t_2 \geq c^e \\ 0 & \text{otherwise} \end{cases}$$

Entry is profitable against an incumbent of type i , if the entrant's anticipated profits

$$\pi^i = (c^i + t_2 - c^e)(a - c^i - t_2) - K > 0 \quad (4)$$

This requires that

$$c^i + t_2 \geq [a + c - \sqrt{(a - c^e)^2 - 4K}] / 2 \equiv C \quad (5)$$

C is the critical level of foreign competitiveness which determines the profitability of entry. Obviously, the question of entry is meaningful only if K is less than the entrant's monopoly profit. As K rises from zero to this maximum level, C rises from c^e to the monopoly price. For $i=H$ and $t_2=0$, C is the minimum value of c^H consistent with the assumptions of the model. I also assume that c^H is low enough to prevent the entrant from charging his monopoly price under free trade, $(a+c^e)/2$. If the entrant finds himself pitted against a type L incumbent under free trade, he shuts down and loses K . All this can be summed up as,

$$a > (a+c^e)/2 > c^H \geq C > c^e \geq c^L \quad (6)$$

A tariff of $t_2 = C - c^L$ can induce entry even if the incumbent is low-cost. The question is whether this tariff is time-consistent, requiring us to consider the government's optimal post-entry tariff for a homogeneous-product Bertrand duopoly. If the incumbent is high-cost, free trade is optimal, since any tariff only raises the price ceiling imposed on the domestic firm by the foreign firm's presence. If the incumbent is low-cost, the entrant's presence prevents her from raising her price above c^e , and a tariff slightly less than $c^e - c^L$ enables the government to soak up the entire foreign rent without allowing inefficient domestic production or raising the price to consumers. In both cases, anticipating the optimal post-entry tariff does not change the entry decision. However, it does make entry devastating for the incumbent, whose duopoly profits are now zero regardless of

type. This incidentally rules out signalling in the reverse direction (as in Klevorick and Prusa 1997), since the L type will never want to signal high costs and attract entry.

Assuming initially that an arbitrary tariff t_1 is in effect in period 1, consider two scenarios regarding the government's tariff policy for period 2:

i) No Commitment (NC): The government imposes the optimal tariff that maximizes period 2 welfare, contingent on its updated assessment of the foreign firm's type and the market structure in period 2.

ii) Assured Protection (AP): Before period 1, the government makes a credible commitment of $t_2 = C - c^L$ to justify entry in case the incumbent reveals low costs. If she reveals high costs, entry is profitable without protection, and the government reverts to the optimal policy of free trade in period 2.

Our evaluation of these policies begins with the case where the incumbent is low-cost, which occurs with probability $1-h$. Under NC, the limit price type L will charge in period 1 can be obtained by solving (2) as an equation for type H:

$$M^H(P_L(t_1)) + \delta M^H(t^L) = M^H(t_1) + \delta D^H(0) \quad (7)$$

From Lemma 1, $t^L = (a - c^L)/3$. Making the appropriate substitutions, (7) becomes

$$(P_L - c^H - t_1)(a - P_L) + \frac{\delta(2a - 3c^H + c^L)^2}{36} = \frac{(a - c^H - t_1)^2}{4} + 0 \quad (8)$$

Type L will have to charge a limit price ϵ below the smaller of the two roots of this equation in order to signal its costs. (Ignoring this ϵ for subsequent analysis is conventional.) Assume that $2a - 3c^H + c^L > 0$ (reversing this inequality still results in (12), which yields a contradiction for $d \leq 1$). Then

$$P_L = [3(a + c^H + t_1) - d(2a - 3c^H + c^L)] / 6 \quad (9)$$

where $d \equiv \sqrt{\delta}$.

We also obtain the limit quantity:

$$y_L = [3(a - c^H - t_1) + d(2a - 3c^H + c^L)]/6 \quad (10)$$

We are interested in conditions under which limit-pricing occurs, that is when P_L is below type L's monopoly profit-maximizing price for period 1, $(a + c^L + t_1)/2$. The necessary condition is

$$d > \frac{3(c^H - c^L)}{2a - 3c^H + c^L} \quad (11)$$

This condition is also sufficient to establish that condition (2) is fulfilled for type L. In other words, limit-pricing is incentive-compatible provided the future is not too heavily discounted. From (9), note that for large enough d , the limit price can be depressed below c^L : if period 2 monopoly profits are large enough, the incumbent might even "dump" its exports below cost in period 1 to deter entry.

I now make a brief detour to consider a different interpretation, from the perspective of the foreign country. Suppose the gap between the two cost levels is a covert export subsidy, committed for both periods. Unsubsidized foreign costs are known to be c^H . The effect of subsidization on the foreign price is now non-monotonic, with three distinct ranges. (R1): Subsidies close to zero have the normal effect, reducing the price by half the per-unit subsidy. However, from (6), once the subsidy exceeds the critical level $c^H - C$ that makes domestic entry unprofitable, it must be signalled with a discontinuous reduction in the price. (R2): For further increases in the subsidy level, (9) shows that the price is increasing in the subsidy, while (R3) an even greater subsidy, by reversing (11) does not induce the incumbent to charge a price lower than its monopoly price, which of course continues to decline in the subsidy level. The perverse effect in range R2 is because the H (unsubsidized) type's gain from signalling a subsidy is reduced by the higher tariff ($t^L > t^H$, from Lemma 1) this draws in period 2 when it retains its monopoly. This justifies a smaller first-period sacrifice (higher price), and therefore a higher limit price by the L (subsidized) type trying to distinguish itself.

We already know from elementary theory that subsidizing an exporting monopolist is welfare-reducing: part of the subsidy becomes a free gift to overseas consumers. This obviously holds in range R1. What about the effect of signalling behaviour and entry deterrence? Foreign welfare is the subsidized monopolist's profit minus the subsidy amount, weighting the second period again by δ :

$$W^s = [(P_L - c^L - t_1) - (c^H - c^L)]y_L + \delta[M^L(t^L) - (c^H - c^L)(a - c^L)/3]$$

An unsubsidized firm's monopoly profit (and therefore foreign welfare) is simply $M^H = (a - c^H - t_1)^2/4$ in the first period and zero when it is displaced in the second period. Substituting from (9) and (10), $M^H - W^s$ yields a complicated expression which simplifies dramatically to $\delta(c^H - c^L)^2/4 > 0$: the unsubsidized outcome is better. Hamilton's "extraordinary indemnifications" are thus a costly way for the foreign government to retain its overseas monopoly. This is partly because in the present setting, the subsidized firm has to charge an even lower price to signal its subsidy, thereby enhancing the "gift" to overseas consumers. It is also because the NC regime provides for optimal countervailing of a revealed subsidy by a higher tariff in period 2. This result can be shown to hold even for range R3 when the subsidy is so large that (11) is reversed and the entry-detering subsidy does not need to be signalled.

Returning to the main discussion, (11) can alternatively be written in terms of a minimum market size (relative to the spread between the incumbent's two possible cost levels) that justifies entry-deterrence:¹⁰

$$a > \frac{3(c^H - c^L) + (3c^H - c^L)d}{2d} \quad (12)$$

In order to permit $d \leq 1$, we must assume

¹⁰ This can alternatively be interpreted as a maximum spread between cost levels, which potentially conflicts with the requirement implied by (6), that $c^H - c^L$ weakly exceed $C - c^e$. However, it can be shown that for $d > 0.75$, a stronger restriction on a reconciles these requirements even for the largest permissible value of $C - c^e$, with C close to its maximum level (the entrant's monopoly price) and $c^e = c^L$. The weaker restriction (12) however suffices for the ensuing welfare results.

$$a > 3c^H - 2c^L \quad (13)$$

These parameter restrictions are independent of t_1 . The government's choice of t_1 therefore does not influence whether limit-pricing occurs, although it does of course influence the limit price, by (9). However, the government is uninformed in period 1, and must set the optimal t_1 on the basis of its prior assessment of the incumbent's type, and also the likely behaviour of type L, which in turn depends on the government's anticipated period 2 tariff. Assuming (6) and (13) hold, the government's NC policy induces limit-pricing by type L, while type H can do no better than charge its monopoly price. Ex-ante, the optimal t_1 can then be found by substituting the quantities exported by the two types into an expression for expected welfare, which can be maximized with respect to t_1 to yield:

$$\hat{t}_1 = \frac{(a-c^H)}{3} + \frac{d(1-h)(2a-3c^H+c^L)}{9} \quad (14)$$

This is decreasing in h , to $(a-c^H)/3 = t^H$ for $h=1$. Following Collie (1991), we can interpret $-(\partial \hat{t}_1 / \partial c^L)$ as the optimal countervailing duty (CVD) to increases in the perceived export subsidy in range R2. This is negative here, contrasting with Collie's result that increases in foreign subsidies should be partially countervailed by higher duties, even in the absence of domestic production. The reduction in the CVD here is due to the perverse price effect of subsidies in R2. Collie's result is valid in R1 and R3, and also for the optimal t^L in period 2, which varies inversely with c^L and therefore directly with the subsidy. However, such duties will not pass the injury test required by GATT: a domestic firm whose entry is deterred does not exist, and therefore cannot be injured!

For the rest of this section, in order to cut down on the algebra, I set $c^L = 0$. (This simplification was delayed in order to derive the preceding results on export subsidies, and because (13) is used in the next section.) This, along with (6) and (13), gives

$$a > 3c^H \geq 3C > c^L = 0 \quad (15)$$

The preceding analysis was valid for a policy of NC. With a policy of AP, the government commits to $t_2=C$, so the home firm enters, completely displacing imports and breaking

even with a price of C . With entry guaranteed, the type L incumbent will not sacrifice first-period profits by limit-pricing. With both types maximizing profits, the optimal period 1 tariff is therefore given by Lemma 2:

$$t^*_1 = (a - hc^H)/3 \quad (16)$$

With tariff rates, market structures and outputs pinned down and consistent with rational behaviour, the ingredients for welfare expressions for AP and NC can now be obtained. The superiority of AP is demonstrated separately for the two realizations of the incumbent's costs. If the incumbent is type L, the preceding analysis gives:

Outcomes if incumbent is Type L

	Period 1		Period 2			
	y	W	t	y	x	W
AP	$\frac{a-t_1}{2}$	$\frac{(a-t_1)(a-3t_1)}{8}$	$t_e = C$	0	$a-C$	$\frac{(a-C)^2}{2}$
NC	$y_L(t_1)$	$\frac{y_L^2}{2} + t_1 y_L$	$t^L = a/3$	$a/3$	0	$a^2/6$

y_L is as given in (10), while C embeds domestic costs as given in (5).

Note that domestic profits never enter these welfare calculations, because the domestic firm just covers its entry costs under AP, and does not enter under NC. This, along with the assumed functional forms and Bertrand competition, is what yields simple welfare expressions for most outcomes. It is y_L in period 1 under NC that makes the comparison non-trivial. Even before dealing with this, an intertemporal trade-off is immediately apparent. In period 1, the higher quantity due to limit-pricing makes NC superior to AP. However, in period 2, (15) easily suffices to establish that welfare is higher under AP. This is because the pro-competitive "pecuniary externality" of entry on consumer surplus justifies protecting the domestic firm from a low-cost foreign rival. It is not immediately clear that the delayed

gratification provided by AP will eventually dominate NC for large enough d , since a larger d also increases the terms-of-trade gain from limit pricing in period 1 under NC.

In order to investigate this trade-off, we must first substitute the ex-ante optimal tariffs (14) and (16) for t_1 in the welfare expressions. This gives an unwieldy expression for comparing welfare under the two regimes, especially with period 2 welfare also being weighted by a factor of $d^2 \equiv \delta$. Two special cases permit comparison. First, for d less than or equal to the minimum given by (11), the type L incumbent will not find it profitable to charge anything less than its static-monopoly price, and there will be no difference in period 1 outcomes between the two regimes. The superiority of AP in period 2 thus makes it the preferable policy. Second, for $d=\delta=1$, an explicit comparison becomes possible:

$$\omega \equiv W^{AP}(t_1^*) - W^{NC}(\hat{t}_1) = \frac{a^2(h^2 + 2) - 3a[c^H(h^2 - 20) + 18C] - 9[4(c^H)^2 - 3C^2]}{54} \quad (17)$$

Note that

$$\frac{\partial \omega}{\partial c^H} = \frac{(20 - h^2)a - 24c^H}{18} > 0 \quad (18)$$

and for $c^H = C$,

$$\omega = \frac{9C^2 + 3aC(h^2 - 2) - a^2(h^2 + 2)}{54} > 0 \quad (19)$$

with both expressions unambiguously positive for the assumed $a > 3c^H$ and $c^H \geq C$. Along with the latter inequality, (18) and (19) together imply that $\omega > 0$ for all parameter values compatible with limit-pricing in the special case with $d=1$. It is also possible to show that $\partial \omega / \partial d$ evaluated at $d=1$ is strictly positive. Therefore, at least for these two ranges of d , AP is superior to NC in case the incumbent has low costs.

If the incumbent is high-cost, the period 2 outcome under both NC and AP is "duopoly" under free trade, with the entrant capturing the market and charging a price equal to c^H . With entry guaranteed, type H can do no better than charge its static monopoly price in period 1. The uninformed government's optimal period 1 tariff, however, is influenced by

the behaviour of a type L incumbent, which as we have seen is contingent on whether the government's strategy is AP or NC. With a foreign monopolist of type H, single period welfare is concave in t and maximized at t^H . Since $\hat{t}_1 > \bar{t}_1 > t^H$, the tariff entailed by AP provides higher welfare in period 1. AP is thus the preferable policy in case of a type H incumbent as well.

4. POST-ENTRY COURNOT DUOPOLY

Retaining parameter restriction (13) from the Bertrand case for comparison, a very different time-consistency issue arises when the post-entry duopoly is characterized by a Cournot equilibrium. The entrant's anticipated duopoly profit against a type i incumbent is

$$\pi^i = [(a + c^i - 2c^e + t_2)^2 / 9] \quad (20)$$

If the incumbent is type L, we assume as before that the entrant cannot make profits under free trade. The entry promoting tariff is now the t_2 that equates (20) to entry costs, for type L:

$$t_e = 3\sqrt{K} - (a - 2c^e + c^L) \quad (21)$$

However, from Lemma 1, a rational entrant can expect an uncommitted welfare-maximizing government to impose a tariff of $t^L = (a - c^L)/3$ on its low-cost foreign rival. We need to investigate whether this will support entry. For this, we need the sign of

$$t^L - t_e = [4a + 2c^L - 6c^e - 9\sqrt{K}] / 3 \quad (22)$$

Note that under free trade, entry is profitable against type H, so

$$\pi^H = [(a + c^H - 2c^e)^2 / 9] \geq K \quad (23)$$

Taking positive square roots,

$$9\sqrt{K} \leq 3(a - 2c^e + c^H) \quad (24)$$

Substituting this into (22) implies

$$t^L - t_e \geq [4a - 6c^e + 2c^L - 3(a - 2c^e + c^H)]/3 \quad (25)$$

However, the right side of this equals $[a - 3c^H + 2c^L]/3$, which is positive by (13) from the Bertrand case. Hence, $t^L - t_e > 0$, so the domestic firm will enter in anticipation of the optimal post-entry tariff. With entry guaranteed, the type L incumbent will not sacrifice first-period profits by limit-pricing.

Thus, with Cournot competition, the NC and AP regimes overlap: time-consistent government policy also credibly gives "assured protection", and limit-pricing will not be observed. Whether this entails a significant welfare loss can be judged by comparing AP/NC with a policy in which the government commits before period 1 to a non-optimal tariff for period 2, but this time one that is lower than the entry-promoting t_e . Since single-period welfare is strictly concave in t , a period 2 tariff just below t_e maximizes welfare in that period subject to the no-entry constraint, and still elicits limit-pricing by a low-cost incumbent in period 1. A regime committing to this period 2 tariff will be called Entry Prevention (EP). Comparing this with NC/AP again involves an intertemporal trade-off: EP offers gains from limit-pricing in period 1, while NC/AP yields the pro-competitive effect in period 2.¹¹ Unfortunately, the output and welfare expressions are far too complicated to arrive at any definite result.¹² Milgrom and Roberts (1982) themselves used a numerical simulation, and an attempt (see Bhattacharjea 1993, chapter 4) to replicate their analysis in the present context, using their numerical parameter values, suggests that EP is preferable. However, this result is obviously dependent on the values chosen, and not too much reliance should be placed on its generality. It does however

¹¹ Bhattacharjea (1995) shows that with a time-consistent tariff before and after entry, privately profitable entry by one domestic firm into a home market with a foreign monopoly necessarily increases welfare.

¹² For the record, the limit price is

$$P_L = \frac{a + c^{H+t_1}}{2} - \frac{d \sqrt{[(a - 2c^e + c^{H+t_2})(5a + 2c^e - 7(c^{H+t_2}))]}}{6}$$

- (24) demonstrate a particular situation in which--despite a parameter configuration similar to the Bertrand case--the optimal policy is not to protect the infant industry, but to prevent it from being born. Reversal of policy prescriptions as between Bertrand and Cournot models is pervasive in the strategic trade literature, but this illustrates it in a new context.
- (25)

5. CONCLUSIONS

In answer to the question posed in its title, this paper has shown that Hamilton's characterization of the entry-detering behaviour of foreign monopolists, and the desirability of countering it with protection, can be modelled according to the requirements of twentieth-century economics. However, both are fragile, depending on particular parameter configurations and Bertrand competition. Further, Hamilton actually wrote of foreign "combinations", which have been interpreted as monopolies. However, as Bagwell and Ramey (1991) show, with multiple incumbents (as distinct from multiple types of a single incumbent), coordinated limit-pricing is impossible, and separation occurs at non-distorted oligopoly prices. Entry-promotion, whenever appropriate (as in period 2 of both the Bertrand and Cournot formulations above), can then be achieved without the pre-entry sacrifice analyzed here. This paper also demonstrated that while entry-deterrence might be rational for the the foreign firm, a subsidy to achieve this objective is welfare-reducing for its government.

References

- Bagwell, K. and G. Ramey, (1991). "Oligopoly Limit Pricing." *Rand Journal of Economics*, 22: 155-72.
- Bhattacharjea, A., (1993). *Strategic Trade Policy for Developing Countries*. Unpublished Ph.D. dissertation, Boston University.
- Bhattacharjea, A., (1995). "Strategic Tariffs and Endogenous Market Structures: Trade and industrial policies under imperfect competition". *Journal of Development Economics*, 47: 287-312.
- Brainard, S.L. and D. Martimort, (1997). "Strategic Trade Policy with Incompletely Informed Policymakers", *Journal of International Economics* 42, 33-66.
- Brander, J.A., and B.J. Spencer, (1981). "Tariffs and the Extraction of Foreign Monopoly Rents Under Potential Entry." *Canadian Journal of Economics* 14: 371-89.
- Collie, D., (1991). "Anti-dumping and Countervailing Duties under Oligopoly: Comment", *European Economic Review* 35, 1185-87.
- Collie, D. and M. Hviid, (1993). "Export Subsidies as Signals of Competitiveness", *Scandinavian Journal of Economics* 95, 327-339.
- Dixit, A., and A.S. Kyle, (1985). "The Use of Protection and Subsidies for Entry Promotion and Deterrence." *American Economic Review* 75: 139-152.
- Fudenberg, D., and J. Tirole, (1989). "Noncooperative Game Theory for Industrial Organization: An Introduction and Overview." In R.Schmalensee and R.Willig (eds.), *Handbook of Industrial Organization*, Amsterdam: North-Holland. Volume 1, 259-328.
- Goldberg, P.K., (1995). "Strategic Export Promotion in the Absence of Government Precommitment". *International Economic Review* 36: 407-
- Hartigan, J.C., (1994). "Dumping and Signalling". *Journal of Economic Behaviour and Organization*, 23: 69-81.
- Horstmann, I.J., and J.R. Markusen, (1992). "Endogenous Market Structures in International Trade (*Natura facit saltum*).". *Journal of International Economics* 32: 109-129.
- Kabiraj, T., (1993). "Tariffs versus Licensing in the Presence of Fixed Costs", *Journal of International Trade and Economic Development*, 2: 27-41.
- Karp, L.S., and J.M. Perloff, (1995). "Why Industrial Policies Fail: Limited commitment". *International Economic Review* 36: 887-905.

Katrak, H., (1977). "Multinational Monopolies and Commercial Policy," Oxford Economic Papers 29, 283-91.

Kolev, D.R., and T.J. Prusa, (1997). "Tariff Policy for a Monopolist under Incomplete Information". NBER Working Paper 6090 (Cambridge MA).

Leahy, D., and J.P. Neary, (1996). "International R&D Rivalry and Industrial Strategy without Government Commitment". Review of International Economics, 4: 322-38.

Levy, S., and S. Nolan, (1992). "Trade and Foreign Investment Policies Under Imperfect Competition: Lessons for Developing Countries." Journal of Development Economics 37: 31-62.

Milgrom, P. and J. Roberts, (1982). "Limit Pricing and Entry Under Incomplete Information: An Equilibrium Analysis." Econometrica 50: 443-59.

Miyagiwa, K. and Y. Ohno (1995). "Closing the Technology Gap under Protection". American Economic Review 85: 755-70.

Neary, J.P., (1994). "Cost Information in International Subsidy Games: Should governments help winners or losers?" Journal of International Economics 37, 197-218.

Qiu, L.D., (1994). "Optimal Strategic Trade Policy under Asymmetric Information," Journal of International Economics 36, 333-354.

Stegeman, K., (1989). "Policy Rivalry Among Industrial States: What Can We Learn from Models of Strategic Trade Policy?" International Organization 43: 73-100.

Stiglitz, J.E., (1987). "Technological Change, Sunk Costs and Competition." Brookings Papers on Economic Activity no. 3, 883-938.

Sutton, J., (1989). "Endogenous Sunk Costs and Industrial Structure." In: Market Structure in the New Industrial Economics, ed. G. Bonnano and D. Brandolini. Oxford: Oxford University Press.

Wright, D.J., (1995). "Incentives, Protection and Time-Consistency". Canadian Journal of Economics 28: 929-38.

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