1. Introduction

Despite more than a quarter century of intense research into the phenomenon of intra-industry trade (the import and export of goods belonging to the same industry, hereafter abbreviated as IIT), several important puzzles remain: the existence of IIT even at highly disaggregated levels of classification, the growing significance of IIT in developing countries, and the contradictory results of econometric studies that seek to relate IIT to economies of scale or trade policy. After a brief recapitulation of the evidence, and why existing theory does not adequately explain it, I present a model that provides a new explanation, which of course could be one of several.

Most empirical studies of IIT define an `industry' at the 3-digit level of the Standard International Trade Classification. However, several authors have found significant IIT even at the 4 and 5 digit levels. One response has been to question the principle of classification, and dismiss the finding as a statistical artefact (Vona, 1990). Another is to insist that the goods being traded are indeed differentiated, and to identify them as vertically (horizontally) differentiated depending on whether the unit values of the imported and exported products diverge by more (less) than a certain threshold percentage (Greenaway, Hine and Milner, 1995). Few authors have ventured to suggest that there could be two-way trade in absolutely identical products. However, although the pioneering work by Grubel and Lloyd (1975) was subtitled *The Theory and Measurement of International Trade in Differentiated Products*, it did also pay serious attention to IIT in "functionally homogeneous" products -- that is, products perceived as identical by consumers when available at the same time and place. The explanations Grubel and Lloyd provided for such trade involved differentiation along some other dimension, or a hidden element of comparative advantage. For example, transport costs might make it more economical for one region in a country to export a commodity across a nearby international border, even as another region is importing the same commodity (differentiation by location). A country might also export and import the same agricultural commodity in different seasons, or electricity at different times of day (differentiation by time). Government policies such as subsidies or contractual imports might also result in IIT in identical products. Alternatively, a labour-abundant country located on major trade routes might have an advantage in reconstituting and repackaging consignments into lots of different sizes, and would therefore have a large volume of entrepot trade.

In the decade after the publication of Grubel and Lloyd's book, attention shifted to theoretical models of IIT based on imperfect competition. Among the many offspring produced by the fruitful marriage of trade theory and industrial organization were models of IIT in identical products under international oligopoly (Brander and Krugman, 1983; Dixit, 1984). Dutifully noted in surveys and textbooks, it was regarded as a theoretical curiosity, with attention being lavished on its slightly older siblings, the models of IIT in differentiated products under monopolistic competition. Even Krugman, despite being one of the co-authors of the original model, and publicising it in his surveys in both the older and newer volumes of the *Handbook of International Economics*, readily admitted that "two-way international trade in literally identical products is surely rare" (Krugman 1995, p.1271). This period of benign neglect may now be ending, and several extensions have been offered in recent years: Dastidar (1998) incorporated increasing returns and trade policy into the Brander-Krugman model; Murray and Turdaliev (1999) have generalised it to several firms in several countries; Naylor (1999) has incorporated unionized labour markets into an international oligopoly model; Horn and Levinsohn (2001) have used it to examine international competition policy; while at long last Bernhofen (1999) has successfully subjected a model in this tradition to empirical testing.

However, this show of interest should also draw attention to some of the unsatisfactory aspects of these oligopoly models of IIT. For one, they retain a somewhat *ad hoc* assumption of segmented markets, leaving unexploited arbitrage opportunities between countries.[1] They also share with the monopolistic competition models a vision of firms exercising market power in export markets. The same applies to imperfect competition models of IIT in vertically differentiated products in the tradition of Shaked and Sutton (1984), which are again based on oligopoly at home and abroad. On the other hand, models of vertical IIT in the Heckscher-Ohlin tradition, where superior varieties

[1] Ben-Zvi and Helpman (1992) show that in an international oligopoly where cross-country price differentials are bounded by transport costs, so that no unexploited arbitrage opportunities exist in equilibrium, IIT in identical products does not occur.

require more capital-intensive techniques of production (Falvey 1981; Flam and Helpman, 1987), assume perfect competition everywhere. Oligopolistic industries that are price-takers in competitive world markets do not fit either description, and the 2 x 2 taxonomy in Greenaway, Hine and Milner (1995), formed by classifying models according to small/large numbers competition and horizontal/vertical product differentiation overlooks this mixed case. What seems to be missing in the theoretical literature is an explanation for the significant and rising level of IIT observed in countries whose firms would not be expected to have market power in foreign markets, nor to be exporting horizontally differentiated products,[2] even though they may have oligopolistic home markets and import and export vertically differentiated products.[3]

The final puzzle is the relationship of IIT to some explanatory variables commonly used in the literature. Most authors expect that lower policy-induced trade barriers should promote IIT, just as lower transport costs, smaller shipping distances, and common borders are empirically well established as conducive to IIT. However, trade policy indicators often emerge with regression coefficients that are insignificant, wrongly signed, or inconsistent as between different studies and different indicators. Various measures of scale economies also perform poorly in most studies, which is again bad news for the monopolistic competition models.[4]

The model to be developed below generates IIT in absolutely identical products, with no economies of scale, hidden differentiation or comparative advantage, while retaining the price-taking small country assumption of traditional trade theory. One version can also be applied to vertical differentiation, again under the small country assumption. The key element in this model is the role of import quotas and similar

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[2] Hummels and Levinsohn (1995) carried out a test of a gravity equation consistent with the monopolistic competition model and found that it performed well on a sample of developing countries which did not have these characteristics.

[3] The results of several empirical papers surveyed by Lee (1992) show that developing countries show much greater concentration in the same industries as compared to industrial countries. Early investigations of the extent and nature of IIT in developing countries include Culem and Lundberg (1986) ; see the surveys cited in the following footnote for more recent evidence.

[4] See Tharakan and Calfat (1996) and Perdikis and Kerr (1998, ch.6) for summaries of these findings, and earlier attempts to explain them.

quantitative restrictions (QRs) in permitting oligopolistic home firms to price-discriminate between the protected domestic market and the competitive foreign market. Although many QRs are being phased out and replaced by price-based measures in the course of the implementation of the Uruguay Round agreements, most of the empirical work on IIT pertains to a period when they were still in force. To the extent that the explanation provided in this paper is applicable to this evidence, we should expect a reduction in IIT from the abolition of QRs. On the other hand, the new Bush administration's directive to the United States Trade Representative to investigate measures to safeguard the US steel industry from import competition may result in the reappearance of QRs.

The model is a variation on Bhagwati (1992), who showed that under certain circumstances a tariff allows a domestic monopolist with increasing marginal costs and facing a competitive world market to export, even though exports are not feasible under free trade. This yields "import protection as export promotion" without any of the usual infant industry considerations such as economies of scale and learning by doing that play a central role in the widely cited eponymous paper by Krugman (1984). I extend Bhagwati's idea to protection through QRs, with provision for transport costs and oligopolistic market structures. It turns out that QRs can promote exports in situations where tariffs cannot, and unlike tariffs, they induce intra-industry trade without the usual assumptions of scale economies, imperfectly-competitive export markets, or product differentiation. In fact, we get `cross-hauling' of *identical* products in a setting where firms subject to diminishing returns to scale are price-takers on a competitive world market. Again in contrast to tariff protection, the model also yields a non-monotonic relationship between the degree of import restriction and social welfare.

In relation to earlier work, while there are several models of the effects of QRs in internationally oligopolistic markets, the combination of domestic imperfect competition and a competitive world market has received less attention. Buffie and Spiller (1986) and Eldor and Levin (1990) for example, explored the comparative statics of varying QR levels under this market structure, but ruled out the possibility of exports and therefore IIT. On the other hand, Agarwal and Barua (1994) allow for exports, but maintain a prohibition on imports, again precluding IIT. They also analyzed a particularly favorable configuration of world prices vis a vis domestic demand and costs, and assumed away transport costs. This is only the first of three possible cases explored below in a more general model.

Section 2 briefly restates Bhagwati's result, with some additional observations. Section 3 examines the positive effects of a QR in promoting exports and IIT, first diagrammatically in a simple model with a domestic monopoly and linear demand, and then algebraically for a domestic oligopoly with general demand. Section 4 draws on results obtained by earlier authors to extend the model to cases where the QR is set as a proportion of the domestic market, and where it is auctioned to domestic residents. Welfare analysis is presented in section 5, which also qualifies and extends the results of some of the earlier literature even for a scenario without IIT. Section 6 concludes.

2. Export-promoting tariffs

The setting in Figure 1 is a domestic monopolist facing domestic demand curve ED, the associated marginal revenue curve, and competitive foreign supply S_F at the exogenous world price P_1. Under free trade, the monopolist can charge at most P_1, and thus the effective marginal revenue curve coincides with S_F upto its intersection with the demand curve. The monopolist produces P_1C, with CA being imported, which is the outcome that would obtain if domestic production was perfectly competitive. A tariff at rate t per unit raises the cost of imports to $P_1+t = P_3$. If the monopolist can also export at the world price P_1, effective marginal revenue is now P_3FBS_F, and the monopolist maximizes profits by supplying P_1B to the domestic market at a price of P_3, and exporting BC at the world price P_1. Protection does seem to promote exports, and from being an importer, the home country becomes an exporter of the same good, without any "infant industry" phenomena such as economies of scale or learning by doing.[5]

As Bhagwati (1992) points out, this argument hinges on the world price being high relative to domestic costs. Call this Case I.[6] Now consider the same scenario, but

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[5] The tariff has been drawn so as to maximize the volume of exports. It can easily be seen that any higher tariff will leave this equilibrium unaffected, while a lower tariff will result in a smaller volume of exports. Exports vanish entirely if P_3 cuts the demand curve below point G.

[6] Another possibility, which will not be mentioned again, is that the world price for both exports and

with a lower world price P_2 below the level at which MC and MR intersect. In this situation--call it Case II--it is clear that any tariff merely reduces import competition and never results in exports. This leads to an important qualification to Bhagwati's argument. He assumed that both imports and exports take place at the same world price, but in the presence of transport costs (or vertical product differentiation, where the domestic variety can only be exported at a discount[7]) the (FOB) export price will be below the (CIF) import price, shrinking the range BC over which exports are forthcoming.[8] In particular, the export price may be below the intersection of MR and MC, even if the import price is above it. Such a situation is depicted in Fig. 1, if P_2 is the export price and P_1 the import price. Call this Case III. Again, exports are unprofitable regardless of the tariff.

Even if it promotes exports, a tariff reduces welfare, as conventionally measured by the sum of consumer and producer surpluses, even after including export profits. It is easy to see that welfare declines monotonically in the tariff. Going back to Case I, although exports are maximized at tariff rate *t*, welfare is in fact minimized; the area corresponding to the deadweight loss is triangle FBA. Note also that with this tariff in place, the monopolist charges a price from domestic consumers that is higher than what it would have charged under autarky, since the possibility of exporting induces it to restrict domestic sales even more than it would have otherwise.

3. Export-promoting quantitative restrictions

3.1: A simple model

From the literature on non-equivalence of tariffs and quotas under imperfect competition beginning with Bhagwati (1965), we know that for the same degree of import restriction,

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imports lies above the intersection of the domestic demand curve with the monopolist's MC curve, but below the monopolist's autarky price (not drawn). The monopolist then exports under free trade -- but exports even more with tariff protection.

[7] In this interpretation, the domestic and imported "varieties" are perfect substitutes in domestic production and consumption -- indeed they are the same product -- but the domestic variety can only be exported at a lower price due to foreign consumers' perceptions or unfamiliarity with its quality.

[8] Even in Cases I and II, we need to assume some positive but arbitrarily small transport costs or quality premium to rule out the possibility of exports under free trade, for otherwise the monopolist would be indifferent between supplying the domestic and foreign markets at a common world price.

a quota gives the monopolist greater monopoly power. This carries over to the case where exports are possible. I shall use the terms QR and quota interchangeably; it is only in their normative implications (discussed in section 5) that quotas differ from so-called Voluntary Export Restraints, or VERs.

To fix ideas, and to heighten the contrast with the tariff case of the previous section, I begin with a diagrammatic exposition using the same rudimentary model. Refer again to Figure 1, allowing for the present that, subject to the qualification in n.8, both exports and imports are possible at P_1 (Case I). With free trade, we have already seen that there are no exports. Tariff rates that raise P_1+t to cross the demand curve in the range GH are prohibitive, but still do not induce exports. Now consider the equivalent quota, that is, a ban on imports. This allows the monopolist to operate anywhere along the domestic demand curve, or export along S_F. Marginal revenue is therefore EBS_F, and the monopolist sells P_1B in the domestic market at price P_3, and exports BC at the world price. This is exactly what was delivered by the export-maximizing tariff depicted in Figure 1.

What about quotas that permit some imports? Assume for the present that import licenses are competitively held, so imports equal the entire quota. The effects of enlarging the quota can be seen by translating the segment EA of the demand curve to the left by the amount of the quota. (At prices below P_1 the monopolist can undercut imports and supply the entire home market along AD.) Figure 2 illustrates this for a quota of JA, which shifts the demand curve confronting the monopolist in the home market so that it is now E'JAD.[9] The corresponding marginal revenue curve follows MR' upto the point vertically below the kink in the demand curve at J, and then jumps up to coincide with the horizontal segment of this demand curve, JA. (This jump is not shown, to avoid cluttering the diagram, but its relevance will become apparent.) However, the export option provides another MR schedule P_1S_F, so that the *effective* MR schedule becomes $E'B'S_F$. The monopolist now maximizes profits by selling P_1B' to the domestic market

[9] Although changes in QRs are invariably represented by parallel shifts of the residual demand curve in the trade policy literature, strictly speaking this assumes either "efficient rationing" of imports, or costless arbitrage between domestic consumers. For clarity, the quota shown exceeds the free-trade level of imports CA, but this is not necessary for the result. Also, remember that we are still considering Case I, so ignore P_2 for the moment.

at a price P_{q1} and exporting B'C, while the quota limits imports to JA. We now observe two-way trade in identical products. Extending this logic, a very large import quota set close to P_1A maximizes exports at almost P_1C, giving essentially the same outcome as with free trade, with *net* imports of CA. Notice from Figure 2 that the monopolist will always produce P_1C, with the changes in the quota level only dividing this amount between the home and export markets by shifting B' horizontally.

In Case II, with the world price at P_2, we saw that a tariff can never induce exports. Unlike in Case I, neither can a ban on imports, as can be seen from Figure 1: MR in the protected home market exceeds that from exports over the entire range P_2K. However, a large enough quota can result in exports. The one illustrated in Figure 2 makes it optimal for the monopolist to supply P_2L to the home market at price P_{q2}, and to export LK. The same outcome obtains in Case III, where imports are available at P_1 but exports can only be sold at P_2 because of significant transport costs, a quality differential perceived by foreign consumers, or a tariff $t = P_1 - P_2$ levied in addition to the QR so as to divert quota rents to the government. (I shall henceforth use the term transport costs to describe the gap P_1-P_2, referring to the other interpretations wherever appropriate.) If the gap is very large, exports and IIT may not emerge at all for modest quotas.

It might seem that a large enough quota can always push the MR' curve to the left of point K, so that exports will eventually emerge. However, enlargement of the quota depresses monopoly profits in the protected home market, while the monopolist always has the option of slightly undercutting the import price and replicating the free trade outcome, supplying P_1C only to the home market at P_1 and earning profits OP_1C. Such a deviation is not attractive in Case I, where both exports and imports are possible at this price, for the monopolist can always earn an extra profit corresponding to an area like $P_{q1}NB'P_1$ over and above OP_1C while continuing to export. But if transport costs are significant, so that exports are possible only at the lower price P_2 (Case III), then the profit from serving both home and export markets (the area of the irregular polygon $P_{q2}MLKO$) will eventually be reduced by quota enlargement to fall below the free trade level of profits, OP_1C. The monopolist will then revert to the free trade outcome,[10] and

[10] Another way of looking at this is to visualize the quota-shifted marginal revenue curve facing the monopolist jumping up to J and then following S_F. This intersects the marginal cost curve again at C,

IIT will disappear. Thus, if transport costs are significant, IIT will not emerge if QRs are either too small or too large, conforming to the considerable empirical evidence (as well as the predictions of the Brander-Krugman model) that IIT is facilitated by low transport costs.

A similar caveat applies to changes in the world price, or changes in the local currency price of imports and exports brought about by exchange-rate changes. This is not illustrated in order to avoid cluttering the diagram, but it can be visualised that for any given quota consistent with IIT, a higher world price (represented by both P_1 and P_2 being higher, given MC) increases the level of exports, but also reduces sales and profits in the domestic market. Once again there is a critical level at which the monopolist does better by undercutting the import price and supplying only the home market.

What this simple model has established is that for a range of configurations of world prices and domestic cost and demand, quotas permit dumping and also IIT in *identical* (or vertically differentiated) commodities for a small country. Exports and intra-industry trade emerge in Cases II and III only after the home market is substantially opened to imports: it is this which depresses domestic profitability so much that the monopolist prefers to export. Further import liberalization increases exports even more, although for a monopolist facing linear domestic demand, exports clearly rise by only half the increase in imports, and that too only until the discontinuous reversion to the free trade outcome described in the preceding paragraphs.

Note from the diagrams that the price at which the monopolist can export plays a role analogous to constant marginal costs in determining the monopolist's profit-maximizing level of domestic sales. Call this price P_x, which is identical to P_1 in Case I and P_2 in Cases II and III. Then P_x represents the constant opportunity cost of serving the domestic market, an analogy that will be used frequently below. Beyond a point,

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creating multiple equilibria from amongst which the monopolist chooses the one yielding the highest profit.

marginal revenue from domestic sales falls below P_x, and it is optimal to supply further output to the world market as long as P_x > MC. In the presence of significant transport costs, the import price, which corresponds to P_1 in Case III, has no role to play in the model, other than demarcating the critical level at which firms revert to the free trade outcome.

Formal welfare analysis is undertaken below, but it is clear that this policy always reduces welfare relative to free trade, and that it amounts to squeezing out an exportable surplus from domestic consumers by shielding firms from competitively-supplied imports and thus reinforcing their monopoly power. In fact, in Case I, with imports barred and export possibilities encouraging firms to restrict their domestic sales even more than otherwise, the domestic price is higher than it would have been under autarky. Demonstrating the paradoxical nature of optimal policies in a second-best world, if for some reason it is not possible to abolish the ban on imports, it is welfare-improving to impose a parallel ban on *exports*.

3.2: A General Model

To formalize this analysis, and extend it to domestic oligopoly and general demand, let the home market be characterized by inverse demand $P = p(Q + \bar{q})$, $p' < 0$, where Q is the home industry's domestic sales and $\bar{q}$ the quota limit on imports. There are *n* domestic firms with strictly convex cost functions, $C_i = C_i(q_i + x_i)$, where q_i and x_i represent the domestic sales and exports respectively of firm *i*, $C(0) = 0$, $C'(.) > 0$, and $C_i''(.) > 0$. Also, $C'(0) < P_x$, otherwise there is no question of exports. The firms compete as a Cournot oligopoly in the domestic market, subject to import competition. Each firm *i* thus takes as given the total output for the domestic market of all other firms q_{-i}, and the quota level $\bar{q}$ set by the government.

Consider Case I to begin with, where (allowing for the negligible difference explained in n.8 above) exports and import are possible at the same price P_x. Firm *i* maximizes

$$\Pi_i \equiv p(q_i + q_{-i} + \bar{q})q_i + P_x x_i - C_i(q_i + x_i) \tag{1}$$

The first order conditions are

$$\frac{\partial \Pi_i}{\partial q_i} q_i p' + P - C_i' = 0. \tag{2}$$

$$\frac{\partial \Pi_i}{\partial x_i} = P_x - C_i' = 0 \tag{3}$$

The model thus far is similar to that employed by Agarwal and Barua (1994), who however ignored the possibility of Cases II and III. They also maintained a prohibitive tariff on imports, precluding the possibility of intra-industry trade. In what follows, I assume all firms are identical to begin with, and return briefly to the asymmetric case below.

(2) and (3) imply that in equilibrium

$$q_i \ p' + P = P_x \tag{4}$$

That is, each firm's *perceived* marginal revenue is equated to the exogenous price of exports, which (as explained in the previous section) is effectively the constant marginal opportunity cost of supplying the home market. Total differentiation of (3) gives $-C'' dq_i - C'' dx_i = 0$, or

$$dx_i = - dq_i \tag{5}$$

(3) determines a firm's total output, while (4) determines its domestic sales, with exports varying as the residual, as shown by (5). The second order conditions for a maximum are

$$\partial^2 \Pi_i / \partial q_i^2 = (2p' + q_i \ p'' - C'') < 0 \tag{6}$$

$$\partial^2 \Pi_i / \partial x_i^2 = - C'' < 0 \tag{7}$$

$$\frac{\partial^2 \Pi_i}{\partial q_i^2} \frac{\partial^2 \Pi_i}{\partial x_i^2} = (2p' + q_i \; p'' - C'')(- C'') > (- C'')^2 = [\frac{\partial^2 \Pi_i}{\partial q_i \; \partial x_i}]^2 \tag{8}$$

Convexity of the cost function satisfies (7), which also enables (8) to be written as

$$(2p' + q_i \, p'') < 0 \tag{9}$$

which in turn, along with (7), satisfies (6), establishing the concavity of the firm's profit function in its own output in an equilibrium with exports.

With prohibitive QRs in cases II and III, equations (3) and (4) -- and hence (5), (7), (8) and (9) -- are redundant, since satisfaction of (2) leaves the firm with its perceived marginal revenue above P_x and therefore with no incentive to export. Totally differentiate (2) and rearrange to get

$$(2p' + p'' q_i - C'') \, dq_i + (q_{i''p} + p') \, dq_{-i} + (q_i \, p'' + p') d\bar{q} - C'' \, dx_i = 0 \tag{10}$$

The last term on the LHS is zero in Cases II and III, before any exports emerge, and with symmetric firms, $dq_{-i} = (n - 1) \, dq_i$. Making these substitutions in (10) and rearranging,

$$\frac{dq_i}{d\bar{q}} = \frac{p' + q_i \, p''}{C'' - [(n + 1)p' + nq_i \, p'']} \tag{11}$$

Using symmetry again, $Q = nq_i$ and $dQ/d\bar{q} = n(d \; q_i / d\bar{q})$. Using an amalgam of Seade (1985) and Buffie and Spiller (1986), define

$E \equiv - (Q + \bar{q})p''/p'$, the elasticity of the slope of the market demand curve;

$s \equiv Q \; / (Q + \bar{q})$, the share of the domestic industry in total availability; and

$k \equiv 1 - (C''/p')$.

E is zero, positive or negative as the market demand curve is linear, convex or concave. Then (11) can be written

$$\frac{dQ}{d\bar{q}} = \frac{sE - n}{n + k - sE} \tag{12}$$

The necessary and sufficient conditions for stability of the oligopoly equilibrium, adapting Seade (1985), are $k > 0$, which is satisfied by our assumption of convex costs, and $n+k-sE > 0$. Consequently, the effect of quota relaxation on domestic output can go either way, depending on the sign of $sE-n$. Many analysts preclude a "perverse" expansionary effect by assuming the so-called Ruffin condition, or the Hahn stability condition, both of which imply $E < 1$. However, the weaker Seade conditions keep open the possibility of a perverse effect, although they do impose the restriction that (12) must be less than unity in absolute amount. I highlight this as a Lemma for future reference:

LEMMA: $|(dQ / d\bar{q}| < 1$

Consequently, liberalization must increase domestic availability ($Q + \bar{q}$) even when it depresses domestic output:

$$\frac{d(Q + \bar{q})}{d\bar{q}} = \frac{k}{n + k - sE} > 0 \tag{13}$$

Quota relaxation must therefore reduce the domestic price. Differentiating (1), and using the first order conditions to apply the envelope theorem,

$$\frac{d\Pi}{d\bar{q}} = p'Q < 0 \tag{14}$$

These basic comparative static results can be summed up as:

PROPOSITION 1: Quota relaxation reduces (increases) domestic output as sE is less (greater) than n, but always reduces domestic price and profits.

Seade's stability conditions limit the possibility of the perverse case to

$$n < sE < n+k \tag{15}$$

I show in the Appendix that quota enhancement eventually makes *sE* drop out of the critical region defined by (15). Assume therefore that a large enough relaxation of the quota depresses domestic sales sufficiently to produce exports even in Cases II and III, provided transport costs are not so large as to induce the firms to revert to supplying only the domestic market before that point is reached. Let $\bar{q}_o$ be this critical minimum level of the quota at which exports emerge, and $\bar{q}_r$ the level at which the reversion to the domestic market occurs.[11] Thus (2), (3) and (4) describe a possible equilibrium with exports in all three cases, subject to $\bar{q}_r > \bar{q}_o \geq 0$, with $\bar{q}_o$ equal to zero in Case I and strictly positive (and inversely related to P_x) in Cases II and III. This can be summed up as

PROPOSITION 2: If transport costs are not too high, some non-zero level of quantitative restriction on imports results in exports of the same product by an imperfectly-competitive industry which could not export under free trade or under tariff protection, and thus leads to intra-industry trade in identical products.

Once exports have emerged after the QR has been enlarged beyond the critical

[11] In the symmetric oligopoly case, each firm's reservation payoff is the profits it can earn by undercutting imports and supplying only the home market upto the point where $P_m = C'$. When quota relaxation depresses per-firm profits below this level, all firms simultaneously find a deviation to this outcome attractive, precluding a potential Nash equilibrium with exports. The case of asymmetric costs is discussed below.

level $\bar{q}_o$, we can retrace the previous analysis from (10), this time applying (5), to find that the effect of quota relaxation on total industry exports X is

$$\frac{dX}{d\bar{q}} = -n\frac{dq_i}{d\bar{q}} = \frac{n - sE}{n - sE + 1} \equiv m \tag{16}$$

(This could have been obtained directly from (10) by noting that in the exporting equilibrium, the world price acts as a constant marginal cost, so that $k = 1$.) In Figure 1, with linear demand and a single domestic firm, $n = 1$ and $E = 0$, so $m = 1/2$: exports rise by half the amount the quota is relaxed, as argued informally in the previous subsection. In the general case, the impact on the "trade balance", or *net* exports for this particular product is necessarily negative: writing $dM = d\bar{q}$, (16) implies

$$\frac{d(X - M)}{d\bar{q}} = \frac{n - sE}{n - sE + 1} - 1 = \frac{-1}{n - sE + 1} < 0 \tag{17}$$

In other words, "export promotion" via quota relaxation is self-defeating: exports increase by less than the additional imports permitted. (In the "perverse" case discussed above, exports actually fall.) And recall that exports emerge only after the quota is relaxed beyond $\bar{q}_o$. This gives us

PROPOSITION 3: Relaxation of the QR always reduces <u>*net*</u> *exports of that commodity.*
COROLLARY: Prohibition of imports is the optimal (net) export-promoting policy.

In Cases II and III, of course, this optimal policy "maximizes" net exports at zero. Even for Case I it is, as was pointed out informally above and will be shown formally in section 5, a very costly way of promoting exports.

For the rest of this section, following from the earlier discussion, I assume that any equilibrium involving IIT must be characterized by market demand low enough and/or quota large enough, to rule out the perverse output response described above. This means that $n > sE$, so $0 < m < 1$ in (16). With QR relaxation serving to increase both imports and exports, it is obvious that it raises the volume of IIT, but it may be useful to derive a quantifiable relationship. Consider adapting the standard Grubel-Lloyd (1975) index to an individual commodity:

$$G \equiv 1 - \frac{| X - M |}{X + M} \tag{18}$$

From (16),

$$G = 1 - \frac{| m(\bar{q} - \bar{q}_o) - \bar{q} |}{m(\bar{q} - \bar{q}_o) + \bar{q}} \tag{19}$$

For $\bar{q} > \bar{q}_o = 0$ (Case I),

$$G = 1 - \frac{1 - m}{m + 1} \tag{20}$$

For the monopoly/linear demand example, m = 1/2, so G = 2/3 for Case I at all levels of the quota until firms revert to the domestic market. For cases II and III, G = 0 upto $\bar{q}_o$ and rises asymptotically to 2/3 as the quota is increased beyond that level. Of course, since m depends on sE and hence on the quota level itself, it can be be treated as a constant only for linear demand, or for very small changes in the quota. However, the important point is that a range of values of the IIT index is consistent with this model.

In principle, all the foregoing results are unaffected if we allow for domestic firms to have asymmetric costs, as long as the least efficient firm is exporting some output in an initial equilibrium. Then, as Agarwal and Barua (1994) showed with a prohibitive tariff on imports, the firms operate symmetrically in the domestic market, with only their exports inversely related to their cost levels. The interpretation given above of the world price P_x as the relevant MC curve helps to see this immediately: although each firm may have a different cost function, they all have this common opportunity cost, whose intersection with the common quota-shifted perceived MR curve determines their equilibrium in the home market. The gap between this and each firm's individual MC curve (corresponding to LK in Figure 2) represents its exports, which is inversely related to its cost level.

Our comparative static results concerning *changes* in the QR also go through in an IIT equilibrium with heterogeneous firms. However, the reservation profit levels obtained by undercutting the import price and supplying only the domestic market will obviously be higher for the lower cost firms, whose deviation will undermine the price-discriminating equilibrium at lower levels $\bar{q}_r$ of the QR. As each such firm deviates to supply an amount like P_1C to the home market, the residual demand curve facing the remaining firms moves left by the same amount, tipping the balance for those with slightly higher costs and inducing them to deviate as well. The IIT equilibrium may unravel and be relevant only to very restrictive QRs, or not at all.

4. Extensions

4.1: Proportional quotas

QRs on imports are often imposed in terms of a maximum share of the domestic market, rather than an absolute amount. A recent result derived by Denicolo and Garella (1999) can be incorporated into our model. Their Proposition 1 showed that with proportionate quotas and constant marginal costs (which is effectively the case in our IIT equilibrium), domestic consumption is unaffected by changes in the market share of reserved for imports. Consequently, domestic output falls (and so exports rise) one-for-one with increases in the level of imports. In our notation, $m = 1$, and therefore G = 1 in Case I In cases II and III, G remains zero until the critical level at which exports are induced, and then rises asymptotically towards unity, dropping to zero again when domestic firms revert to competitive behavior as described above.

4.2: "Sleeping" Quotas

Suppose the import licenses that provide access to the quota-restricted imports are auctioned to domestic residents. Cunha and Santos (1996) have derived conditions under which a monopolist facing competitive imports finds it profitable to buy up the quota licences and not utilize them. Their analysis, though rewarding, is somewhat cumbersome. Our model has the same market structure, and a diagrammatic exposition makes the analysis of pre-emption and `sleeping' quotas much more tractable, and also provides a new result.

Referring again to Case I of Figure 2, the monopolist's purchase of any part of the quota at auction would have two effects on its profit-maximization problem. First, the portion of its marginal cost curve above P_1 would be translated to the right by the amount of the quota it obtains. This is because the quota is effectively a second plant for producing the same product at a cost of P_1, and the marginal cost curve is now the horizontal summation of MC and P_1 up to the amount of the quota the monopolist holds. In Figure 2, the monopolist is assumed to buy the entire quota JA, and thus (recalling that P_1 also represents the marginal opportunity cost of domestic production in the presence of the export option) its effective marginal cost curve follows P_1Q (where CQ = JA by construction) and then MC' in Case I. Effective MC is P_2Q' and then MC' in Case II, and P_2KCQ and then MC' in Case III.

The second effect of purchasing the quota is to give the monopolist the ability to shift the residual demand curve back to the right by the amount of the quota it chooses not to utilize. The corresponding marginal revenue curve also shifts, and so does the equilibrium point B' in Figure 2. The augmented marginal cost curve MC' is also translated leftwards by the amount of the quota that is not used. But B' cannot lie to the right of B, which is the equilibrium point when imports are completely shut out, and is therefore necessarily to the left of C in Cases I and III (see Fig. 1). The augmented MC' curve extends rightwards from C in these two cases, and is thus irrelevant to the monopolist's problem. This also illustrates Cunha and Santos' proposition that the monopolist does not use any part of the quota that it acquires. I deal with Case II below.

It remains only to check whether the monopolist finds it worthwhile to outbid a competitive fringe of importers to pre-empt all or part of the quota. I confine myself to the case where the quota is perfectly divisible and is auctioned off piecemeal. With the translation of the MC curve being irrelevant in Cases I and III, the value of a marginal unit of the quota to the monopolist is identical to the effect on its profits of tightening the quota by that amount. A marginal tightening of the quota increases its profits by the negative of (14). Using (2), (3) and (14),

$$-\frac{d\Pi}{d\bar{q}} = P - P_x > 0 \tag{21}$$

in any equilibrium in which the monopolist is exporting, and

$$-\frac{d\Pi}{d\bar{q}} = P - C' > 0 \tag{22}$$

when it is not, with marginal cost reinterpreted to include the possibility of the monopolist also becoming a trader in the imported product when it buys part of the quota. Recall from n.8 that the export price must be at least slightly lower than the import price P_m. The fringe importers will bid at most P-P_m per unit to secure quota rents. Hence the monopolist will outbid them in any equilibrium in which it is exporting, as long as any licenses remain unsold. This results in pre-emption of the entire quota in Cases I (with some exports remaining) and III (with exports extinguished). In both cases, the monopolist's effective marginal cost remains below P_m for every unit until the quota is sold out. In Case II, the monopolist buys and does not utilize LK of the quota and stops exporting. For the remainder of the quota $C' > P_m$, and the fringe traders outbid the monopolist (compare Cunha and Santos' Proposition 7). In all three Cases, recalling the earlier comparative static results on quota relaxation, we get

PROPOSITION 4: Auctioning an import quota results in a reduction of exports and IIT (possibly to zero), but an improvement in the trade balance and an increase in the domestic price and monopoly profit.

Just as an increase in the quota increased exports, but by less than the increase in imports, the pre-emption of the quota reduces imports by more than it reduces exports. In effect, the monopolist switches its capacity away from exports to domestic sales to replace the imports it has succeeded in keeping off the market by pre-empting the quota. These results have an interesting implication for political economy. Many governments, especially in developing countries, are more interested in fiscal revenue, protecting powerful domestic industrial interests, and in controlling the balance of payments through administrative measures, than in maximizing the usual anodyne notion of social welfare. Such a government could further its objectives while appearing to yield to pressures to be more "market friendly", by relaxing quotas and auctioning them. The enlarged quotas would be fully or partly bought up and "put to sleep" by the monopolist, the government would pocket the revenue, the reduction in monopoly profit would be limited,[12] and deterioration of the `trade balance' (in this single commodity) prevented or ameliorated, despite the apparent liberalization of import restrictions.

5. Welfare analysis

Despite the reservations expressed in the preceding paragraph, I do not intend to sidestep the conventional notion of social welfare as the sum of domestic consumer and producer surplus, plus any quota rents. With the usual quasi-linear specification of consumers' utility, this is :

$$W = \int_0^{Q+\bar{q}} P(v)dv - PQ + n[Pq - C(q)] + [(P - P_m)\bar{q}] \tag{23}$$

So that

$$\frac{dW}{d\bar{q}} = P\frac{dQ}{d\bar{q}} - [(nq + \bar{q})\frac{dP}{d\bar{q}} + P\frac{dQ}{d\bar{q}}] + n[q\frac{dP}{d\bar{q}} + P\frac{dq}{d\bar{q}} - C'\frac{dq}{d\bar{q}}] + [(P - P_m) + \bar{q}\frac{dP}{d\bar{q}}] \tag{24}$$

which simplifies to

[12] It would be reduced by (slightly more than) $P\text{-}P_m$, which is what the monopolist must pay for one unit of the quota license in order to outbid the traders, instead of the reduction of $P\text{-}P_x$ that a marginal relaxation of the quota would have otherwise entailed

$$\frac{dW}{d\bar{q}} = (P - C')\frac{dQ}{d\bar{q}} + (P - P_m) \tag{25}$$

This is of course positive if quota relaxation has the perverse expansionary effect on domestic output. Assuming the conditions that rule out perverse case, Eldor and Levin (1990) derived a similar expression, and showed that it was still positive for $P_m < C'$. The sign of (25) remains ambiguous otherwise. Our analysis permits us to probe deeper. The "perverse" case is not pathological; for a domestic monopoly (which is what Eldor and Levin assumed) it always holds for a small increase in a prohibitive quota if demand is iso-elastic. In that case, $s = n = 1 < E < k + 1$ in (15). Even absent the perverse case, our exporting equilibrium, which is ruled out by their assumption that $P_m < C'$, in fact provides another way of resolving the ambiguity. In such an equilibrium, as noted several times above, the home market price and quantity are determined as if domestic firms faced the same constant and identical marginal cost P_x, even if their individual marginal production costs are dispersed and increasing in q. The same applies to comparative statics involving the welfare expression. For, as can be seen from Figure 2, profits corresponding to area OP_1C (in Case I) remain unchanged and only profits corresponding to P_1q_1NB' change as the quota is varied -- exactly as if marginal costs were constant at P_1. Changes in consumer surplus and quota rents depend on the domestic price, which again is determined by this "as if" MC. This allows us to replace C' with P_x in (25). This still does not resolve the ambiguity, but in Case I where essentially $P_m = P_x$, we get

$$\frac{dW}{d\bar{q}} = (P - P_x)(\frac{dQ}{d\bar{q}} + 1) \tag{26}$$

which is strictly positive, by the Lemma in section 3.2. Clearly, this will continue to hold if the gap between P_m and P_x is not too large. Thus, extending the Eldor-Levin result,

PROPOSITION 5: With quota rents accruing to domestic residents, relaxation of a quota improves welfare if it either (a) has an expansionary effect on domestic output, or (b) the import price is lower than domestic marginal costs, or (c) the domestic industry exports at a price that is not much lower than the import price.

If there are exports and transport costs are too high, quota liberalization may result in a welfare *loss*. This is attributable to the wasteful cross-hauling of the same good, as demonstrated in a different context by Brander and Krugman (1993).[13] If the quota is pre-empted by the monopolist at auction, relaxation has no effect on welfare; it merely transfers some rents to the government without benefiting consumers.

In the case of Voluntary Export Restraints (VERs), however, quotas are allocated to foreign suppliers and the rents go abroad. (By the same token, they cannot be auctioned at home, and there is thus no question of a domestic firm pre-empting them.) Eldor and Levin (1990) showed that a VER that marginally relaxes an import prohibition necessarily reduces welfare. It can be easily shown that this result depends once again on their ruling out perverse output responses to the QR. Dropping the last expression on the right side of (23) now gives

$$\frac{dW}{d\bar{q}} = (P - C')\frac{dQ}{d\bar{q}} - p'\bar{q}\left(\frac{dQ}{d\bar{q}} + 1\right) \tag{27}$$

Evaluated at $\bar{q} = 0$, the sign of this is identical to that of $dQ/d\bar{q}$. The Seade condition allows the sign of this derivative to be positive in certain circumstances, and the Eldor-Levin result can be thus be qualified and generalized as

PROPOSITION 6: A voluntary export restraint that marginally relaxes an import prohibition increases (decreases) welfare if E is greater (less) than n.

In Case I, where an import prohibition results in exports, P_x as usual replaces C' in (23): the one-for-one diversion of output from the shrinking domestic market into

[13] In the present formulation, transport costs erode the margin for quota rents -- which is also why they do not figure explicitly in the analysis of VERs that follows.

exports softens the impact of import penetration on domestic profits and welfare.

This marginal relaxation of a prohibitive QR is rather uninteresting, and for non-zero VERs the second term in (27) counteracts any negative effect from the first term. Eldor and Levin showed that the effect of further relaxation can be described as a U-shaped relationship between the welfare level and the permitted level of imports. Farrell and Shapiro (1990) obtained a very similar result for a domestic oligopoly, by treating a tightening of an import quota as analogous to an output-reducing merger by foreign firms, while Syropoulos (1996) directly modeled VERs selectively imposed on a subset of foreign firms to yield a similar result. In the special case of linear demand and constant costs, they showed that welfare reaches a minimum where imports provide for half of domestic consumption, and then rises again as the VER is relaxed further.[14] However, it is possible to derive some additional results with linear demand, in Case I of the present model. In order to show that the ensuing result carries over to extend the earlier authors' non-IIT models with constant costs, and to exploit readers' familiarity with expressions for a domestic oligopoly equilibrium, I shall use *c* to represent the marginal cost level, which can be replaced by P_x in the appropriate context.

With linear domestic demand $P = a - b(nq_i + \bar{q})$, the *i*th firm's profit function becomes

$$\Pi_i = [a - b(q_i + q_{-i} + \bar{q}) - c]\, q_i \tag{28}$$

The usual techniques give us the symmetric equilibrium quantity

$$q(\bar{q}) = \frac{a - b\bar{q} - c}{b(n+1)} \tag{29}$$

[14] Dixit (1984) and Richardson (1998) obtain similar welfare results for the entry of oligopolistic foreign firms into the domestic market under free trade. The results are similar to the relaxation of a VER because foreign profits do not enter domestic welfare, just like the quota rents for a VER, and because of the assumption of Cournot competition. The latter means that domestic firms treat the quantity supplied by each foreign firm as given, so that comparative statics with respect to an exogenous change in the number of foreign firms is the same as that with respect to an exogenous change in a VER. This holds whether the VER applies to all or only some foreign firms, provided the restrained and unrestrained firms have the same costs, as in Syropolous (1996).

Welfare is the sum of consumers' and producers' surplus:

$$W = a(nq + \bar{q}) - b[(nq + \bar{q})^2]/2 - P(nq + \bar{q}) + n(P - c)q \tag{30}$$

Substituting (29) into (30) and simplifying,

$$W = \frac{b^2 \bar{q}^2(2n + 1) - 2nb\bar{q}(a - c) + n(n + 2)(a - c)^2}{2b(n + 1)^2} \tag{31}$$

Differentiating (31) with respect to $\bar{q}$ and equating to zero gives a simple expression for the VER level at which welfare is at a minimum:

$$\bar{q}_{Wmin} = \frac{n(a - c)}{b(2n + 1)} \tag{32}$$

Substituting this back into (29) gives

$$q(\bar{q}_{Wmin}) = \frac{a - c}{b(2n + 1)} \tag{33}$$

It can be easily shown that the quantities given by (32) and (33) correspond to an import share of half the domestic market, as shown by the authors mentioned above. However, going a step further, the reduced-form expressions enable us to calculate the minimum welfare level itself. Substituting (32) into (31),

$$W(\bar{q}_{Wmin}) = \frac{n(a - c)^2}{b(2n + 1)} \tag{34}$$

This is the trough of the U-shaped curve mentioned above. Evaluating (31) at $\bar{q} = 0$ gives the welfare level under autarky:

$$W(0) = \frac{n(n+2)(a-c)^2}{2b(n+1)^2} \tag{35}$$

Dividing (34) by (35),

$$\frac{W(\bar{q}_{Wmin})}{W(0)} = \frac{2(n+1)^2}{(2n+1)(n+2)} \tag{36}$$

It can readily be seen that this expression is equal to 8/9 for n = 1, and rises asymptotically to unity as n increases. Further, equating the expressions in (31) and (35) gives the critical VER at which welfare recovers to the autarky level (that is, where the right branch of the U rises to the level where the left branch began):

$$\bar{q}_c = \frac{2n(a-c)}{b(2n+1)} \tag{37}$$

Substituting this into (29) gives the output level of the representative domestic firm at this critical level of the VER:

$$q(\bar{q}_c) = \frac{a-c}{b(2n+1)(n+1)} \tag{38}$$

Finally, the market share of imports at this critical level can be obtained as

$$\frac{\bar{q}_c}{\bar{q}_c + nq(\bar{q}_c)} = \frac{2(n+1)}{2n+3} \tag{39}$$

Eldor and Levin (1990) showed for a domestic monopoly (n =1) with constant costs that relaxation of the VER returns welfare to its autarky level when imports capture 80% of the home market. (39) generalizes this to domestic oligopoly with possibly dispersed and increasing costs, showing that the larger the number of domestic firms, the greater the import penetration required to restore the autarky level of welfare.[15] With even a handful of domestic firms, the required level of import penetration could be well over 90%. The new results derived here can be summed up as

PROPOSITION 7: With linear domestic demand, if all domestic firms either (a) export under autarky or (b) have constant and equal marginal costs, then relaxing a VER reduces welfare by upto 1/9 of the autarky level, and restores the autarky level only when the restricted imports capture at least 80% of the domestic market.

Paradoxically, the critical level of the VER given by (37) at which welfare is restored to the autarky level is quite likely to exceed the free trade level of imports! Further relaxation beyond this level given does raise welfare towards its free trade level; this may even occur as a discontinuous jump at more restrictive VERs, if the defection repeatedly mentioned above causes an IIT equilibrium to break down. For these two reasons, the U-shaped curve relating welfare to the level of import penetration should be more accurately described as a J-curve.

Admittedly, QRs that restrict imports to "only" 80% or more of the market are unheard of, and a government that has already allowed this level of import penetration would surely prefer free trade. However, since tightening the usual kind of restrictive VER can improve profits, welfare and the trade balance (even with IIT), conceivably it can appeal to some governments, who might prefer to climb the left-hand branch of the J rather than slide into its trough with partial liberalization.

6. Conclusions

This paper has presented a model of intra-industry trade in identical or vertically differentiated products in a setting that has not been explored before for this purpose:

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[15] A similar result on entry by foreign oligopolists under free trade is derived in Bhattacharjea (2000). See also the previous footnote.

oligopoly at home and competition in the rest of the world. Admittedly, this is only one of several possible market structures, but there seems to be growing recognition amongst theorists that different models are needed to analyze different products entering into international trade. The model also lacks the grandeur of general equilibrium models of IIT, and does not even pretend to model the microfoundations for vertical product differentiation. It also cannot predict the extent and pattern of IIT between specific pairs of countries with different characteristics.

Given these limitations, in terms of its positive predictions, the model shows that QRs can induce IIT in a narrowly defined commodity, consistent with virtually any level of the Grubel-Lloyd index. The QR must be loose enough to allow for some imports, but not so loose as to cause the reversion to the free trade outcome discussed above. The threshold levels of the QR that demarcate the range where IIT occurs depend on the configuration of domestic demand, firm costs, world prices, and transport costs (or quality differentials). It is hardly surprising, then, that the relationship between QRs and IIT has not been picked up by cross-section econometric studies. On the prescriptive side, the model shows that although a QR can promote exports, it causes a welfare loss, except locally in the case of an already restrictive VER. For the special case of linear demand, I demonstrated results that went some way beyond those in the existing literature to show the extent of welfare loss resulting from the relaxation of such a VER., with or without IIT.

APPENDIX: Effect of quota relaxation on domestic market share

Recall that we defined domestic market share as $s = Q/(Q+q)$. Clearly, this falls if quota relaxation has the "normal" contractionary effect on the numerator, since we saw that it must always increase the denominator. Consider the "perverse" case, which prevails when (restating condition (15))

$$n < sE < n + k \tag{A1}$$

Buffie and Spiller (1986) derived a more general version of this condition with conjectural variations. All their comparative static results on quotas involved the additional assumption of iso-elastic demand, for which E is a positive constant equal to $(1 + (1/\varepsilon))$, where ε is the elasticity of market demand. If the domestic industry is a monopoly or behaves as a perfect cartel, they showed that a small increase in a prohibitive quota ($s = 1$) always raises domestic output; a larger increase continues to have the perverse effect if $\varepsilon < 1$ with $s > 0.5$; while if the domestic industry is a Cournot oligopoly, any increase in the quota reduces output. In our context, therefore, the possibility of a perverse output effect arises only for domestic monopoly, and there too (if we rule out $\varepsilon \leq 1$ as incompatible with equilibrium for $s = 1$) only if $0.5 < s < 1$. However, from the definition of s,

$$\frac{ds}{d\bar{q}} = [\frac{dQ}{d\bar{q}}(Q + \bar{q}) - (1 + \frac{dQ}{d\bar{q}})Q]/(Q + \bar{q})^2 \tag{A2}$$

whose sign must be the sign of the expression in the numerator, which simplifies to

$$\frac{dQ}{d\bar{q}}\bar{q} - Q \tag{A3}$$

This must be strictly negative. For, suppose not. Then

$$dQ / d\bar{q} \geq Q / \bar{q}. \tag{A4}$$

However, the RHS > 1 for $s > 0.5$, while we already showed that the LHS < 1. Therefore, our supposition is incorrect, and (A3) and thus (A2) must be negative. Therefore (with constant demand elasticity) sE must eventually drop out of the critical region defined by (A1).

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