A MODEL OF COUNTERTRADE

by

Tore Ellingsen
London School of Economics and Political Science

The Toyota Centre
Suntory and Toyota International Centres for
Economics and Related Disciplines
London School of Economics and Political Science
Houghton Street
London WC2A 2AE
Tel.: (020) 7955 6674

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Abstract

Countertrade – or reciprocal buying – is defined as a transaction involving (at least) a two-way transfer of goods, rather than a singular transfer of goods for money. The main objective of this paper is to explain the extensive use of countertrade both between countries and between firms within one country.

In a simple game-theoretic model it is shown that countertrade may be a rational business strategy for firms with buying power, and that the impact on welfare is negative, even in the case where no firm exists.

The model is consistent with the observations that countertrade occurs mainly in homogeneous goods industries, that trades are relatively balanced, and that the practice is more widespread during recessions than during booms.

Keywords: Countertrade, reciprocal buying, two-way transfer of goods, game-theoretic model, rational business strategy, homogeneous goods industries.

1. INTRODUCTION.

Countertrade is usually defined as any transaction involving (at least) a two-way transfer of goods, rather than a singular transfer of goods for money. Barter is a special case where only goods are transacted, but more generally countertrade occurs whenever today's seller as part of the agreement promises to buy something, possibly of different value, from today's buyer at a future date.

A substantial amount of world trade is governed by countertrade agreements. The estimates vary, but based on a variety of sources Hveem et.al. (1988) argue that in the period 1985-1988, more than 15 percent of world trade may have been governed by countertrade agreements. Also, reciprocal buying - which is the industrial economics label for countertrade - is widespread among business firms within the same country. According to McCreary and Guzzardi (1965), around 60 percent of the Fortune 500 U.S. firms had their own "trade relations" departments in the mid sixties. (More detailed information on the importance of reciprocity for large American firms is provided by Allen (1975)).

An illustrative example of countertrade is the case of E.I. Du Pont de Nemours, for many years U.S.A.'s largest explosives maker, and also owning divisions for producing plastics, chemical products, synthetical fibres, etc.[1] During the 20's and 30's Du Pont used its large purchases of steel to countertrade with steel makers, such as Bethlehem Steel, who were vertically integrated into iron ore mining, buying steel in return for selling explosives. Occasionally, when Du Pont's own purchases were not large enough, the firm even used its good contact with General Motors to convince reluctant steel makers to buy its explosives. Similar countertrade options were not open to the more specialized Atlas Powder Company and Hercules Powder Company, Du Pont's main competitors in the explosives market.

[1] For a thorough documentation of this particular case, see Stocking and Mueller (1957).

For some reason there are two quite separate scientific literatures on countertrade: one in the industrial organization/antitrust tradition, and one in international trade/international law. My approach relates more closely to the first tradition, but the theory seems no less applicable to international trade.[2]

Like so many topics in industrial organization, reciprocal dealing has been offered more attention by writers on antitrust than by empirical economists. Correspondingly, there has been very little agreement. Whereas some writers, like Hausman (1964) and Turner (1965) are plainly hostile to reciprocity and to conglomerate mergers which increase the countertrade potential, a number of leading antitrust specialists, e.g. Dean (1963), Ferguson (1965), Posner (1970), Steiner (1975) and Stigler (1969), take a non-interventionist view. Indeed, some even view it as pro-competitive. Actual policy has likewise followed a varying practice.[3] The Federal Trade Commision challenged the practice on three occasions in the thirties. After World War II, there was taken no action against it in the U.S.A. for almost twenty years. In the beginning of the sixties, the signals from F.T.C. were highly ambiguous. On the one hand they encouraged the official formation of a Trade Relations Association, but on the other they were not willing to grant the practice a per se legality status. As already mentioned, a majority of large American firms had their own trade relations departments, but many companies dared only send their representatives to Association meetings unofficially. Their suspicion was soon proven right. The wind changed against reciprocity with two court decisions; Ingersol Rand, 1963, and - more importantly - Consolidated Foods, 1965[4]. In the latter case, a ten year old merger was challenged on

[2] The two idiosyncratic features of the international trade are exchange rates and taxes (subsidies). I will not attempt to survey the literature dealing with these phenomena. A recent bibliography is Debroy (1987).

[3] I apologize for focussing so strongly on U.S. law and practice, but it has been difficult to find other source material.

[4] For a discussion of these and other cases, see Steiner (1975, Ch.9) and the references cited therein.

the basis of increased reciprocity, and Consolidated was forced to divest. It is however only during a period in the sixties and early seventies that the F.T.C., the U.S. Department of Justice and the courts have been fairly consistently challenging the practice.

The persistent differences in opinion and the inconsistent legal practice seem to have their basis in the absence of a generally accepted theory of reciprocal dealing. Those who oppose it argue that the foreclosure harms other sellers in the market, and constitutes a barrier to entry. Furthermore, reciprocity imposes a constraint on the buyer, who may be forced to buy a product of inferior quality or higher price in order to sell his own goods. Oddly enough, there has been little worry as to the effects on market prices. An exception is Hale and Hale (1964) who state that "prices of both the products involved probably remain higher than they might be absent the element of reciprocity."

There are numerous lines of defense, and the influential Task Force on Productivity and Competition, under the leadership of George Stigler, dismissed reciprocity as an insignificant and innocuous business practice. Personally, I do not find Stigler's (1969) arguments entirely convincing. His only mention of oligopoly is to the case with collusive price fixing. In these circumstances, he agues, reciprocal buying is a way of restoring price flexibility. This argument has also been put forward by a number of other authors, notably Ferguson (1965) and Anderson (1967). However, consider the situation where tacit collusion is achieved as a Nash equilibrium in a repeated pricing game. Ceteris paribus, the most effective deviation is to lower the price. Thus, only in the case where it is harder for competitors to monitor countertrade agreements than price reductions will the possibility of countertrade have an impact on the equilibrium.[5]

[5] However, it is a well known feature of games with imperfect monitoring that "punishment periods" are typically triggered by exogenous events and not by the actions of the players themselves (see Green and Porter (1984) and Tirole (1988, pp. 262-265)). Thus, if this theory is to be taken seriously, the *possibility* of countertrade could trigger a cartel price breakdown, but not - as suggested by Liebeler (1970) - the action itself. In this particular framework, it is also well known that the breakdown of the cartel price leads to the severest possible punishment - which with price competition means price equal to

However, reciprocity is often not kept secret, in which case this argument has no force.

More or less complete explanations of countertrade emerging from the antitrust discussions are that the practice reduces selling costs and uncertainty (Ferguson (1965). Neither have been thorougly investigated. In a related contribution, Williamson (1983, 1984) argues that a reciprocal agreement constitutes a safeguard against the breaking of business contracts. Finally, countertrade has been seen as an instrument of price discrimination. A formal analysis is given by Caves (1974).

Even though there have only been sporadic attempts of empirical analysis, it seems that any theory must be able to explain a few stylized facts. First, the practice is more common in some industries than in others. Thus, it has long been recognized that oil, steel, paper, chemicals and rubber are products which are often traded in this way (see e.g. Lewis (1938)). These industries are fairly concentrated, and the products are homogeneous. Moreover, reciprocity flourishes in recessions and is less common in booms, as shown by Dauner (1967) and also mentioned by Sloane (1961).

The approach taken here is strongly influenced by the informal arguments put forward by Stocking and Mueller (1957). In short, they claim that an economic agent in an imperfectly competitive market wants to increase his market share (as the price typically exceeds marginal cost), and that countertrade offers itself as a way to win customers without undercutting the price.

This explanation is formalized in a simple game theoretic model: There are two industries, A and B, each containing n producers selling a single homogenous good. Only one of the firms in industry A is a buyer in market B, and vice versa. Each market is characterized by Cournot competition. All countertrade is assumed to be made on "market terms"

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marginal cost Thus, it would not be profitable to countertrade in the punishment phase either. So, if Stigler is right about the impact of countertrade on cartel behaviour, there are plausible circumstances in which the phenomenon itself should never occur!

implying in particular that the price is the same for all customers. (Justification for these assumptions can be found in the final section.)

This specification gives rise to a two stage game. In the first stage, the potential countertraders decide whether to reciprocate or not, and in the second stage there is production and trade. As usual, the model is unravelled from the back, so that the countertrade decision depends on the equilibrium profits of the second stage.

The analysis shows that there is indeed a profit shifting motive to countertrade. The agreement increases the trading partners' market share at the expense of their competitors. Moreover, the model is consistent with all the stylized facts listed above. An interesting result from a policy perspective is that the market price typically increases and welfare goes down as a result of the countertrade agreements. The analysis therefore lends considerable support to the restrictive U.S. antitrust practices. Moreover, it is a warning that GATT authorities should perhaps be more concerned about countertrade than is presently the case. Bilateral trading agreements need not involve preferential tariffs or quotas in order to jeopardize the benefits from free trade.

The paper is outlined as follows. In section 2, the notation and basic equations are presented. Then, in section 3, the profit shifting argument is put forward in its purest form. Here, the model is solved under the assumption of zero marginal costs, allowing graphical exposition and analytical comparative statics to an extent not permitted by the more general framework. The full model is analysed in section 4. Here I also trace the empirical predictions that are implied by the model. Some final remarks are collected in section 5.

2. THE MODEL.

There are two n-firm industries, A and B. In industry A, firm AR is a conglomerate which is a buyer of the goods produced in industry B, whereas the other n-1 firms have no use for this product. A typical firm of the latter kind is called AS_i. Firms BR and BS are defined accordingly. The technology is the same for each firm in an industry. Furthermore, I will assume that the industries are symmetric in the sense that for any given price, both total demand, cross industry demand, and costs are the same in both industries. This saves notation and substantially reduces the complexity of the analysis. In particular, we need only study the equilibrium in one of the industries, here taken to be industry A.

There is quantity competition, and the market price is set so as to equate open market demand to open market supply, where "open market" refers to quantities not covered by a countertrade agreement. If there is countertrade, it occurs at market price, and the reciprocating seller cannot ration his trading partner while simultaneously selling to other customers (i.e. the countertrade has priority). Let D denote total demand, being the sum of reciprocal demand, D_r, and demand from ordinary (non-reciprocating) customers, D_n. The strategic variables of the firms are the quantities they supply to the open market. Let R be AR´s open market supply, and let S_i denote the open market supply of AS_i. These quantities, together with open market demand, determine the market price P.

For the duopoly case, the situation with and without reciprocity is illustrated in figures 1a and 1b respectively.

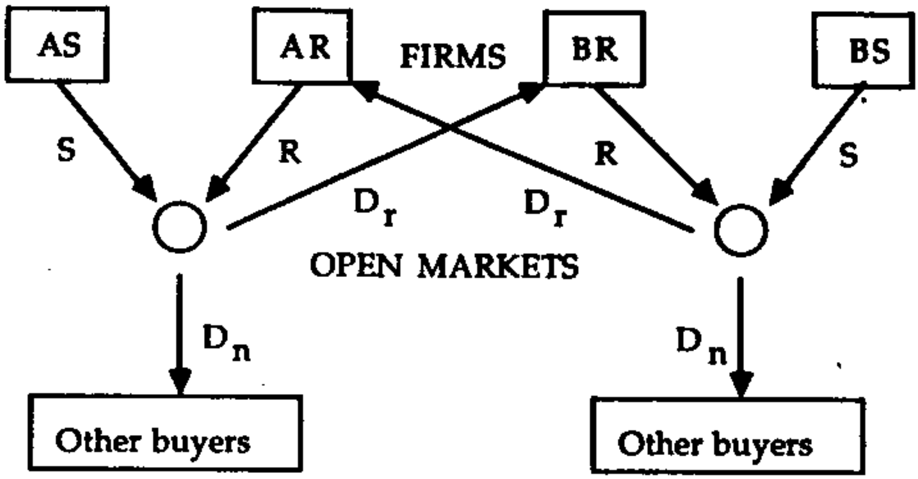

Figure 1a
The situation without countertrade

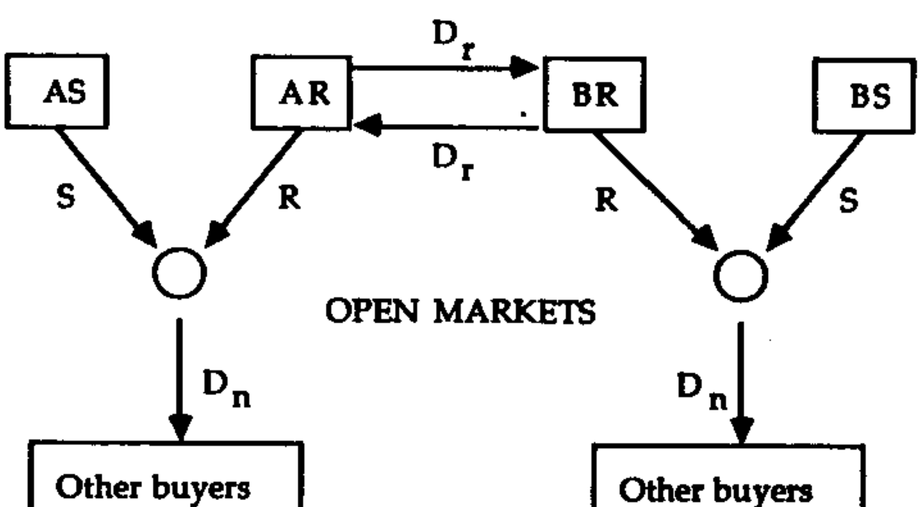

Figure 1b
The situation with countertrade

Demand functions are assumed to be linear, and are written as

$$D_n = (a-P)/b \tag{1}$$

$$D_r = (a-P)/c \tag{2}$$

Consequently, we can express total demand, D, as

$$D \equiv D_r + D_n = [(b+c)(a-P)]/bc \tag{3}$$

where a, b and c are arbitrary positive constants. This formulation of the demand side implies that D_r and D_n are always fixed proportions of D. Furthermore, since we have ruled out rationing of the reciprocal buyer, and since rationing of other buyers is not possible per definition, these demand shares are also going to appear in equiibrium. It is straightforward to find

$$M_n \equiv D_n/D = c/(b+c) \tag{4}$$

$$M_r \equiv D_r/D = b/(b+c) \tag{5}$$

The prices under different regimes are determined by the open market equilibrium conditions. Under free trade (no countertrade), the sum of open market output $(R+\Sigma_j S_j)$, must be equal to total demand, D, and from equation (3) we then obtain the price

$$P_F = a - bc(R+\Sigma_j S_j)/(b+c) \tag{6}$$

Similarly, with countertrade, open market output must equal D_n, and equation (1) gives

$$P_C = a - b\,(R+\Sigma_j S_j) \tag{7}$$

Remember that R and S_i will be determined in equilibrium in each of the two cases, so that we cannot compare P_F and P_C directly from (6) and (7).

The cost function, C, is assumed to be quadratic,[6] and the same for all firms, i.e.,

$$C = e + mQ + (1/2)dQ^2 \tag{8}$$

where Q is quantity produced and e, m and d are constants. (The reason for multiplying by 1/2 is to simplify later first order conditions.)

This is all that is needed in order to write down the profit functions of the firms in the different regimes. Let π_{RC} denote AR's profit with countertrade, let π_{RF} denote AR's profit in the absence of a countertrade agreement, and let π_{S_iC} and π_{S_iF} be the corresponding profits for AS_i.

$$\pi_{RF} = RP_F - (e+mR+(1/2)dR^2) \tag{9}$$

$$\pi_{S_iF} = SP_F - (e+mS+(1/2)dS^2) \tag{10}$$

$$\pi_{RC} = [R+D_T(P_C)]P_C - (e+m[R+D_T(P_C)]+(1/2)d[R+D_T(P_C)]^2) \tag{11}$$

$$\pi_{S_iC} = SP_C - (e+mS+(1/2)dS^2) \tag{12}$$

It is also assumed that the fixed costs, e, are saved in the case of exit.

We are interested in finding the Cournot equilibria with and without countertrade. These equilibria are characterized by their open market quantities $(R_C,S_{1C},..,S_{iC},..,S_{n-1C})$ and $(R_F,S_{1F},..,S_{iF},..,S_{n-1F})$ respectively, where these solves

$$\begin{aligned} R_C &= \max\{0, \operatorname*{argmax}_{R} \pi_{RC}(R,\Sigma_j S_{jC})\} \\ S_{iC} &= \max\{0, \operatorname*{argmax}_{S_i} \pi_{S_iC}(R_C,S_i,\Sigma_{j\neq i} S_{jC})\} \end{aligned} \tag{13}$$

[6] It is shown in the appendix that the results go through for all continuous convex marginal cost functions.

and

$$R_F = \max \{0, \underset{R}{\operatorname{argmax}}\, \pi_{RF}(R, \Sigma_j S_{jF})\}$$

$$S_{iF} = \max \{0, \underset{S_i}{\operatorname{argmax}}\, \pi_{S_iF}(R_F, S_i, \Sigma_{j\neq i} S_j)\} \tag{14}$$

Because of the way the model is specified, it is a sufficient condition for the Cournot equilibria to exist that the marginal cost is nondecreasing (i.e., that $d>0$) and $m<a$. Throughout the paper it is assumed that $d>0$.

When deciding whether or not to countertrade, AR will take into consideration not only the profit from sales, but also the impact of the agreement on the price in industry B. AR's loss of consumers' surplus implied by the countertrade agreement is

$$\Delta \equiv (D_r(P_F)+D_r(P_C))(P_C-P_F)/2 \tag{15}$$

Thus, we have

OBSERVATION 1: It is rational for AR to countertrade if and only if $\pi_{RC}(R_C,S_C) - \Delta \geq \pi_{RF}(R_F,S_F)$.

The welfare implications of countertrade are interesting from a policy viewpoint. There are two reasons why a rational agreement need not be socially beneficial. First, expansion of AR's market share comes at the expense of the competitors in industry A. Secondly, if $P_F \neq P_C$, the buyers on the open market are affected by the countertrade decision. The total consumers' surplus under the two regimes are

$$\Omega_I = (a-P_I)D(P_I)/2 \qquad I \in \{F,C\} \tag{16}$$

and the corresponding welfare is defined as

$$W_I = \pi_{RI} + \Sigma_j \pi_{SjI} + \Omega_I, \qquad I = \{F,C\} \tag{17}$$

This completes the description of the model.

3. PROFIT SHIFTING: THE SIMPLE CASE.

In order to demonstrate the profit shifting mechanism as simply as possible, the model is first solved under the assumption of zero marginal cost. This allows for graphical analysis.

When marginal costs are constant, it is well known (and easy to show) that market size does not influence the Cournot price, as long as both sellers remain active. By the same argument, if one fraction of the demand curve was removed, or given for one of the sellers to monopolize, it would not influence the competition for remaining customers.[7] The profitability of an action taken in one market segment is independent of what happens in the other. Consequently, if we think of the situation without countertrade as one where there is independent competition for reciprocal and ordinary buyers, the countertrade agreement between AR and BR does not alter AS's best response function in the competition for ordinary buyers (denote this best response function $S_n(R)$).

However, the same is not true for AR. After the agreement has been made, AR has a monopoly right of supplying BR, but is restricted to sell this quantity at the price offered to buyers in the open market. This means that AR's profit in one market segment is dependent on the actions taken in the other. In particular, by offering less on the open market, AR can

[7] By a fraction of demand, is here meant a proportion of the demand curve, and not, say, its upper or lower part. Remember that in the present model $D_r(P)$ and $D_n(P)$ are fixed proportions of total demand.

drive the market price up, and thus increase the profit on reciprocal sales. Note that a marginal reduction of AR's supply to ordinary buyers, has only a second order effect on profit in this market segment, whereas the higher price yields a first order impact on profit from reciprocal sales. A diagram illustrating the competition for ordinary buyers is drawn below (figure 2). Here, the decision variables are denoted R_n and S_n, and the diagram shows the best response curves for this market segment.

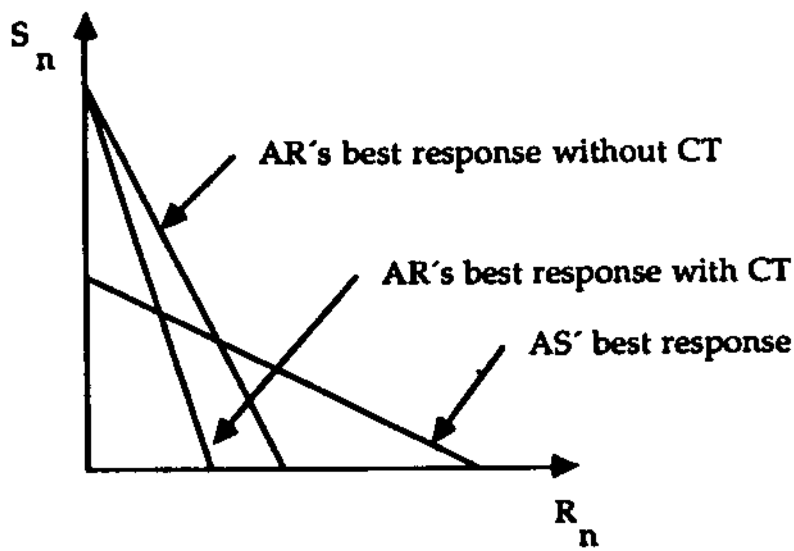

Figure 2
Competition for ordinary buyers

The conclusion is that if countertrade is rational in this case, price will go up, and - in the absence of exit - welfare will go down. From the above argument it is also clear that AR's profit will increase under countertrade with constant marginal costs. The question is whether the profit increases sufficiently to outweigh the loss from buying at a higher price. This problem can be studied with the help of figure 3.

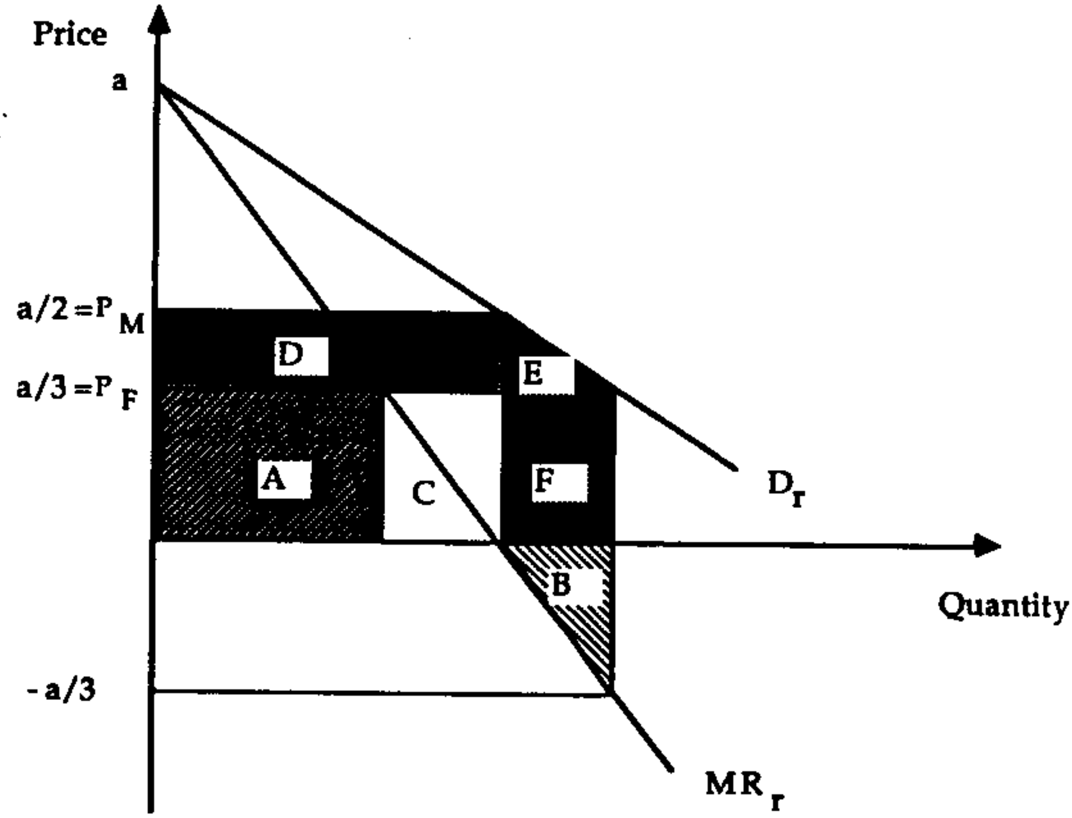

Figure 3

The effect of countertrade on AR´s profit

In this figure, P_M denotes the monopoly price. It is easy to compute the prices P_F and P_M, and find that they are equal to a/3 and a/2 respectively. (Those who do not immediately recognize these familiar monopoly and Cournot duopoly prices are referred to the appendix for explicit analysis). The fact that the marginal revenue at price equal to a/3 is equal to -a/3 is also straightforwardly computed. Moreover, it can be seen geometrically by noting that the MR curve is always twice as steep as the demand curve in this linear case.

Observe first that if AR and BR did not alter their open market outputs, there would be no change in price as a consequence of countertrade, and the effect on AR´s profit would simply be a gain equal to

A. This is the "market foreclosure" effect, from capturing the fraction (here one half) of D_r which was previously served by the competitor, AS. But consider again AR's incentive to increase the price: At P_F, the marginal revenue from selling to BR is negative. Thus, with countertrade, AR will reduce its open market output as long as the marginal increase in countertrade revenue implied by the higher market price outweighs the marginal loss in revenue from open market sales. Clearly, AR will settle for a price between P_F and P_M. In bringing about this higher price, AR does of course impose an extra cost on BR and vice versa. Note in particular that AR, in his capacity as a buyer, always loses considerably more from a price increase than he gains as a seller. This is why it is not possible ex ante to say whether countertrade is rational: After the agreement has been made, the price of the purchased good will increase. Let me therefore consider the extreme case, where $P_C = P_M$. It is sufficient to show profitability here, to conclude that countertrade is profitable whatever the actual P_C.

The direct gain from pushing the price up to the monopoly level is equal to the difference in profit, which is D-F=B. (D-F is obtained by subtracting rectangles, B is obtained by taking the integral of the marginal revenue function in the relevant interval.) Total gains from countertrade are therefore A+B. The costs are twofold. First, AR incurs a loss in open market, because he has to reduce the open market output in order to bring about the higher price. While the actual magnitude of this loss cannot be found graphically, we know that it does not exceed B. (Otherwise it would not have been rational to decrease the open market quantity in the first place.) Secondly, the loss from buying at a higher price is equal to D+E. Thus we can state

OBSERVATION 2: A sufficient condition for countertrade to be profitable in the case where m=d=0 is that A+B > B+D+E, or equivalently, that A>D+E.

It is straightforward to check that the condition holds. The length of A is half the longest side of the trapezoid D+E, whereas the height of A is twice that of D+E. Consequently the area of A is larger than that of D+E. Exactly the same exercise can be carried out for any constant marginal cost (i.e. $m>0$ does not change anything, as long as $d=0$). Finally, note that the higher price brings about a reduction in welfare as defined in (17). This completes the proof of

PROPOSITION 1: In the duopoly case with constant marginal cost, countertrade is always individually rational and socially wasteful.

It is natural to ask whether this result holds under more general assumptions about technology and number of firms. In the next section, I show that it does.

Another interesting question is what happens to the profit of the competitor. On one hand, AS has now irretrievably lost a share of the market. This loss equals A. It is useful to note that A=4B (a simple geometric obsevation). On the other hand the price has also gone up. To see that the net effect is negative, at least in this simple case, look at figure 4.

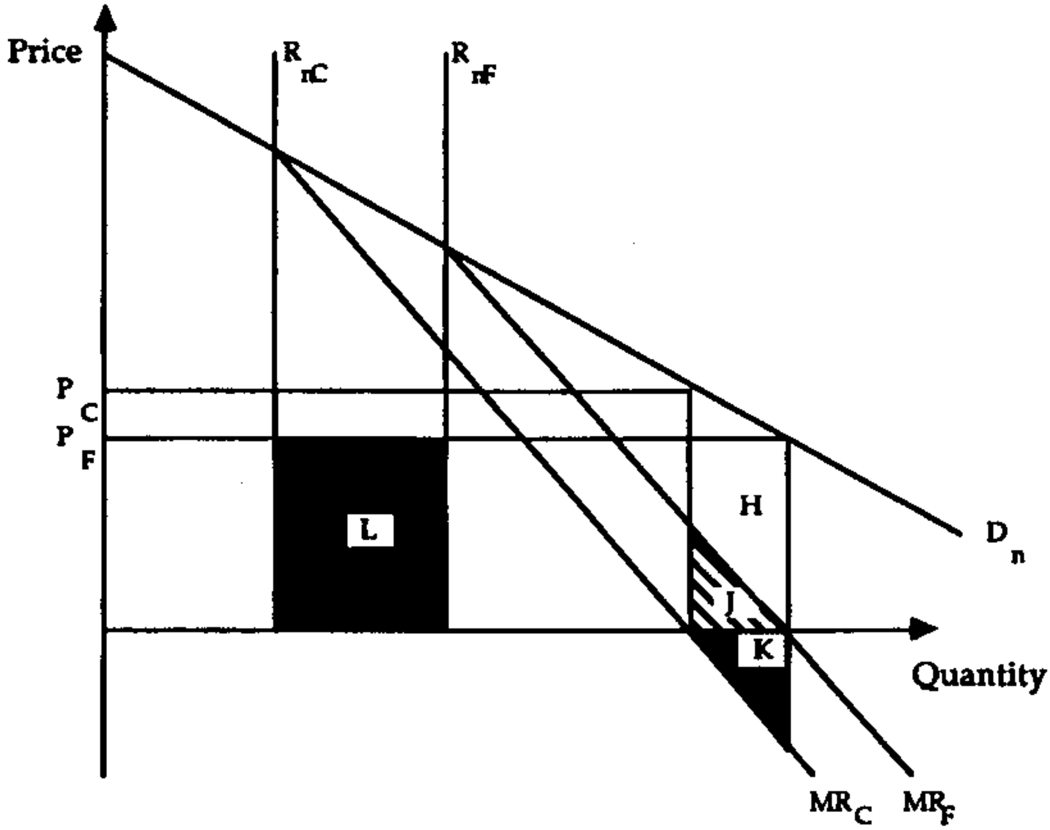

Figure 4

The effect of countertrade on AS′ profit

The figure depicts the choice problem facing AS for a given open market supply by AR. When AR supplies R_{nF}, AS is left with the residual demand, and the corresponding marginal revenue function MR_F. Setting marginal revenue equal to marginal cost (which is zero), AS maximises his profit and determines the price level, P_F. When there is countertrade, AR reduces his open market output to R_{nC}. The residual demand facing AS is higher, and implies a marginal revenue function MR_C. What are the gains and losses? First, AS has gained the share of the open market given up by AR. This is the area L. If AS had kept his supply at a level so as not to change the price, this would have been the only positive effect. But as we know, it is optimal to reduce the output until MR_C is zero, thus gaining an extra profit of K from the resulting price increase. The gains must be weighed against the loss of supplies to BR, viz. 4B. Recall from figure 3, that AR would not give up a larger profit than B in the open market, so L<B. Thus, we have

OBSERVATION 3: AS will gain from AR's countertrade if and only if L+K>4B.

It is relatively easy to check that this condition never holds: the marginal revenue curves are twice as steep as the demand curve, and therefore the horizontal distance between MR_C and MR_F is $(R_{nF}-R_{nC})/2$. Consequently, H+J = L/2. Since J=K, we must have that K<L/2<B/2, and so the total gain (L+K) is less than 3/2B < 4B. I state the result as

PROPOSITION 2: In a duopoly with constant marginal cost countertrade is harmful to the competitor.

This accords well with the fact that complaints about reciprocal buying practices sometimes come from competitors. However, the result does not hold in the n-firm generalization of the model.

4. GENERALIZATION AND COMPARATIVE STATICS.

Whereas the assumptions of linear demand and constant marginal cost definitely limits the relevance of propositions 1 and 2, the restriction to two firms is even more unsatisfactory. Will countertrade still be rational for AR if it faces an arbitrary number of opponents, or can propositions of this kind only be proved for the duopoly case? I start this section with a demonstration that the duopoly assumption is not restrictive for proposition 1. Consider the following figure:

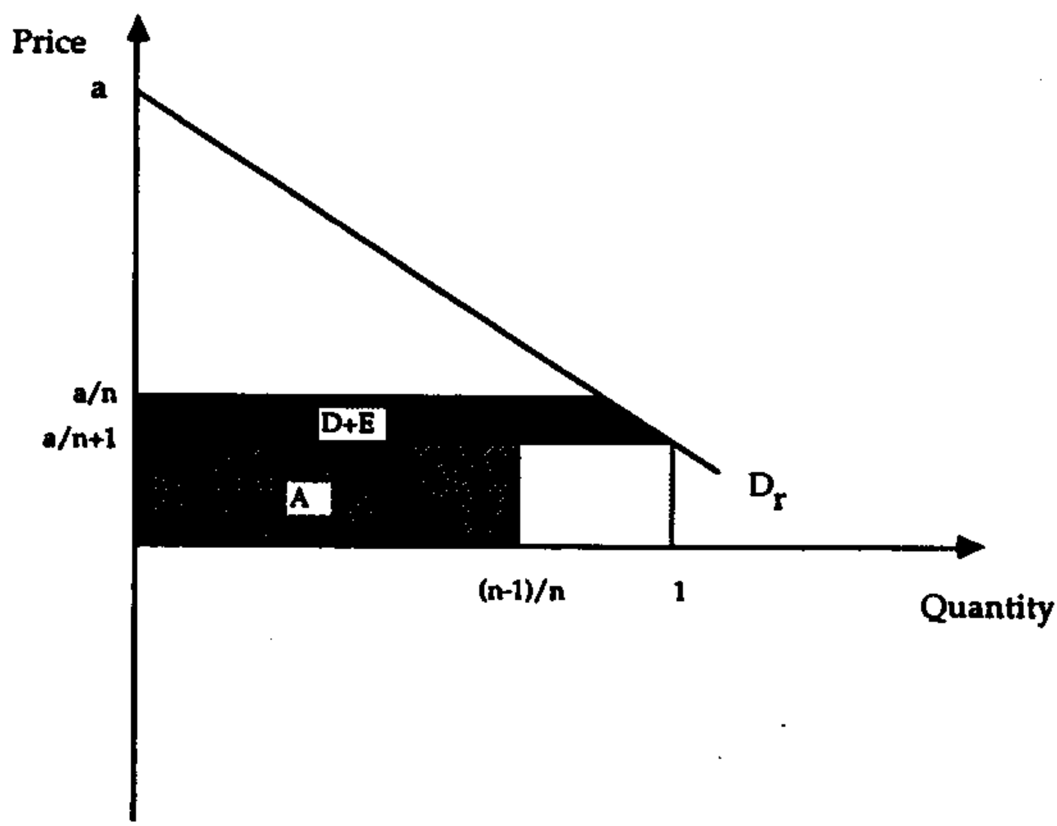

Figure 5:

Profitable countertrade, the n firm case.

Again, this figure depicts the situation least favorable to countertrade, i.e. where the price increase is maximal. From the standard Cournot analysis, we know that the price without countertrade, with n firms is a/(n+1) (if in doubt, consult the appendix). Clearly, the highest price which can prevail under countertrade is then a/n, the price which would prevail if AR withdrew entirely from the open market. The area D+E, the loss from purchasing at a higher price, is then defined as in figure 3. The area A, the pure market foreclosure effect, is found as follows: Initially, AR valued the demand from BR at a fraction 1/n of its total value. Under reciprocity AR is the sole seller to BR, and the total gain evaluated at the pre-existing price is therefore proportional to the fraction of demand previously not served by AR, the fraction (n-1)/n. As previously noted (observation 2), it is a sufficient condition for countertrade to be profitable that A>D+E. Since this condition is fulfilled for n=2 it is sufficient to show that A/(D+E) is an increasing function of n. This is seen directly from the diagram. Having shown that the result extends to the n-firm case, the remaining generalisation is to allow for an upward sloping marginal cost function.

If the more general cost structure is allowed for, graphical analysis is no longer viable. By solving the model algebraically, which is unfortunately a rather tedious task, we can prove a general result. To understand its flavour, I will first present

PROPOSITION 3: (i) If the non-negativity constraint does not bind, the price is higher with countertrade than without. (ii) A necessary, but not sufficient condition for the non-negativity constraint to bind is that $M_r > 1/n$.

Proof: See appendix.

COROLLARY: If AR is active on the open market, if there is no exit, and if marginal costs are non-decreasing, welfare is lower with countertrade than without.

Part (i) of the proposition is striking. It says that even if marginal costs are increasing, so that the open market competition will be intensified with countertrade, AR will always want to withdraw supplies from the open market to such an extent that there is a net price increase. Thus, a sufficient condition for countertrade to be socially harmful is that AR does not cut off all supply to the open market. Part (ii) says that only if the countertrade agreement covers more than a fraction 1/n of the total volume, may AR no longer be an active seller in the open market.

It is natural to ask what would happen if the agreement covered an even larger share of demand? In this case, AR would produce up to the point where marginal costs equal the price on the open market, and buy the residual there. Thus it is quite clear that the market price even in this case would have to increase.

Under what circumstances is the agreement rational? It turns out that proposition 1 generalizes to not only to all quadratic cost functions, but - as shown in the appedix - even to all convex marginal cost functions.

PROPOSITION 1*: For symmetric industries A and B, countertrade is profitable (and socially harmful) if $M_r \leq 1/n$.

Proof: See appendix.

Personally I do not think that this result is obvious. Of course, the larger market share is a cause for increased profit, at least when there is freedom to adjust open market output optimally. The slightly surprising bit is that this increase in profit from sales is always big enough to outweigh the extra cost of buying at a higher price. Furthermore, there is good reason to believe that the result is true regardless of the demand share M_r.[8]

At first glance, this proposition is disturbing from an empirical point of view, as it suggests that countertrade may be rational whatever the market conditions. But remember that so far it has been assumed that the industries A and B are perfectly symmetrical. Thus, Proposition 1* covers only a rather unlikely situation. Consider e.g. the case where the technology and the total demand are symmetric, but AR's purchases in market B are much larger than BR's in A. Here B will be eager to countertrade, because a large buyer can be captured without incurring too large a loss on the more expensive purchase. However, for AR the calculation is exactly the opposite: a small share of the market is captured at the cost of having to make large purchases at a considerably higher price. If the asymmetry is sufficiently large, AR will therefore refuse to countertrade. Consequently, the model predicts that agreements cover transactions of roughly the same size. Large deviations will mainly be observed if the mark-up is significantly different across markets. In this case, the lower sales can be compensated by a high mark-up.

Perhaps the most interesting empirical fact about reciprocal buying is that it occurs more frequently in recessions than during booms (see Sloane (1961) and Dauner (1967), and for international countertrade Banks (1985)). Stocking and Mueller's (1957) explanation of this phenomenon runs as follows. Recessions are characterized by "excess capacity"; in other words, constant marginal cost over a considerable interval. Conversely, booms are characterized by firms operating close to full capacity, and a large expansion of output can only be made at a high cost. Thus, in a recession the seller is keen to increase sales, and the buyer need not fear too heavy price increases. Can this reasoning be captured formally? Obviously, the

[8] The argument is the follwing: Suppose countertrade is always profitable if the non-negativity constraint does not bind. Consider now an agreement covering larger deliveries. Clearly, if AR can buy the residual in the open market to satisfy the demand of BR, this has no adverse effect on competition compared to the case where BR purchases the residual in the open market himself. Thus, the only remaining uncertainty is for trades greater than 1/n of the industry output, but smaller than the total output of AR.

property I want to model is that the marginal cost is more sensitive to variations in output when close to full capacity utilization. In order to do this, I leave the context of a quadratic cost function (the slope of the marginal cost function is constant), and proceed with a piece-wise linear marginal cost function. As already mentioned, Proposition 1* remains valid for this specification too.

Since it has been proved that for symmetrical markets countertrade was always rational, the analytically ideal way to proceed would be to allow for different kinds of asymmetries in the two markets and demonstrate that the range of circumstances under which countertrade is an equilibrium is larger when production is higher. However, the complexity of the proof of Proposition 1* indicates that this is a very cumbersome approach. Consequently, I have preferred to use numerical simulation. Such simulations can be performed in one of two ways. One is to experiment with different parameters (e.g. different M_r's) for each of the two markets. The second, which is the approach chosen here, is to find an index of (in)tolerance towards asymmetry defined in terms of the parameters describing two symmetric markets. The index proposed here is

$$I = \Delta/(\pi_{RC}-\pi_{RF}) \tag{18}$$

By Propositions 3 and 1*, this index takes values between zero and one (at least as long as $M_r<1/n$). A value close to one indicates that the countertrade agreement is only marginally profitable, in the sense that a relatively small difference in buying costs (numerator), or in profits from increased sales (denominator), would suffice to make the parties better off without the agreement. Consequently, a relatively small asymmetry would cause one of the parties to reject reciprocity.

Consider the following example. The shape of the marginal cost function is given by

$$C''(Q) = \begin{cases} 0 & \text{if } 0 \le Q \le 20 \\ 1 & \text{if } 20 < Q \le 40 \\ 5 & \text{if } 40 < Q \end{cases}$$

With this piece-wise linear function, it is fairly straightforward to simulate what will happen for various realisations of demand. Some representative numbers are given in table 1.

a	I		
	$M_r = 1/2$	$M_r = 1/4$	$M_r = 1/10$
50	0.432	0.234	0.097
100	0.646	0.339	0.138
200	0.859	0.437	0.176

Assumptions: $n=2$, $(b+c)/bc=1.25$

Table 1

The pattern is unambiguous.[9] As market conditions get better (a grows larger), the tolerance towards asymmetry decreases and countertrade becomes less likely.

Another pattern revealed by the table is that small trades have a greater tolerance towards asymmetry than do large ones. The intuition is that the larger trades gives the seller a stronger incentive to push up the open market price, and the marginal loss to the buyer becomes large relative to the marginal gain of the seller, thus driving up the index I.

In the previous section, I proved that with constant marginal cost and only two firms in each industry, countertrade would unambiguously harm the competitor. This is a result which does not generalize to the n firm case.

[9] Experimenting with this example, I discovered that the index stays constant over intervals where both firms' output remain on the same linear segment.

PROPOSITION 2*: (i) If $n=2$, profitable countertrade is always harmful to the competitor. (ii) If $n \geq 4$, profitable countertrade is always beneficial to the competitors. (iii) If $n=3$, profitable countertrade is harmful to the competitors for low values of d, and beneficial for high values of d.

Proof: See appendix.

Here we see that the gains associated with less competition (and the resulting higher market price) can outweigh the initial loss of market share. The implication is that only in very concentrated industries, or in industries where there is price regulation, should competitors find reason to complain about reciprocal purchasing practices.

5. FINAL REMARKS.

This paper formalizes the notion that countertrade may be profitable in oligopoly markets. The theory is consistent with known empirical regularities, and has unambiguous welfare implications. It remains to justify the choice of assumptions.

Cournot, or quantity, competition is justified partly on the ground that it is the simplest model which does not too strongly prejudice the welfare analysis. But from the analysis it is clear that the crucial condition for the argument to work is that there is a positive mark-up on the margin and that commodities are fairly close substitutes. This should allow for a fairly wide range of detailed specifications, although it is not true for Bertrand (price) competition. However, there are good reasons to be sceptical about the Bertrand assumption as a description of real industries, in particular when goods are homogeneous and there are no capacity constraints. E.g., if entry costs are positive, and marginal costs are constant after entry, the only subgame perfect equilibrium is a monopoly (with more firms, the short run profit is zero, and sunk costs are not recouped). This is not to say that countertrade would be irrational in the homogeneous goods Bertrand model. Although there would be no profit shifting, a promise to buy from a given seller - rather than from the one who which offers the lowest price - would tend to relax competition, at least in a duopoly. With capacity constraints - the natural consequence of the game where there are long run capacity decisions and short run competition in price (see Kreps and Scheinkman (1983)) - countertrade has the potential to entail profit shifting (the countertrader would have higher expected output) as well as relaxation of competition, just as in the Cournot model above. Such a framework would also allow for a distinction between long run and short run decisions to countertrade, an interesting exercise in its own right. I plan to explore this topic in future work.

A second important assumption is that *all trades occurs at the same price*. A partial theoretical justification is that any discount to a countertrading firm may give rise to arbitrage. However, there seem to be better contracts available (e.g. agreeing on a lower price and an upper limit to purchases). For this reason, I have not attempted to explain the market price clause. On the other hand, as an assumption it has overwhelming empirical support: a survey carried out by Neuhoff and Thompson (1954) showed that 80% of the firms which took part in countertrading stated that their purchases were awarded on the basis of reciprocity only when price, quality and delivery conditions were equal. Similar market price clauses are also very common in international countertrade. Out of the remaining agreements, it is reasonable to expect that a fraction occurred at worse than market terms. E.g., it is documented that U.S. Rubber (now Uniroyal) were willing to purchase at inferior terms if they got a substantial order in return (Stocking and Mueller (1957, pp 86-89)).

The assumption of *asymmetric buying power* is consistent with the observation that reciprocal buying is usually thought of as being dominated by conglomerates. E.g., Scherer (1980) has placed the section on reciprocal dealing in the chapter entitled "Conglomerate size and pricing behavior." Furthermore, countertrade arrangements have most frequently and forcefully been adressed by antitrust authorities in connection with conglomerate merger cases (see Steiner (1975)). A final reason for focussing attention on asymmetric buying power is that countries of different size may well have the same resource base from which to operate as exporters of a particular commodity, whereas the smaller country is able to offer only a fraction of the larger country's counterpurchase. Thus, this specification seems to be of interest when adressing conflicting interests in international trade.

One obvious limitation of the model is that it allows only for *homogeneous products*. The main reason for this is that I have tried to limit the complexity of the analysis. However, it is clearly possible to do the derivations for a Cournot model with heterogeneous goods. Since the mark-up is generally higher in this context, the seller has a strong incentive to capture extra customers. The drawback for the buyer is that the purchases not only are going to be more expensive, but also have the wrong quality. This need not topple the agreement however. Indeed, firms have in practice shown willingness to buy at a high price, or a less preferred quality, when the seller is a good customer. As already mentioned this was not uncommon in U.S. Rubber.

However, when the heterogeneity gets more important, the loss from inefficient purchasing will eventually outweigh the profit gain. Only when goods are fairly homogeneous is the profit shifting argument decisive.

It is remarkable that countertrade is a practice which has been hailed mainly by the strongest proponents of free markets, even more so as Adam Smith was so indignantly against it.[10] Smith was annoyed with the English preferential treatment of Portuguese wine (reciprocating the comparatively large Portuguese purchases of English manufacture), calling

[10] See *The Wealth of Nations*, e.g. the edition by Edwin Cannan, New York, 1937, p. 460.

countertrade an art of "underling tradesmen," and continuing: "A great trader purchases his goods always where they are cheapest and best [...]" However, whereas my model supports the view that countertrade is harmful to overall welfare, it has also shown that clever tradesmen may well have reason to engage in it.

APPENDIX.

Here I give a short summary of the formal analysis of the general model.

Supposing that no firm exits, the equilibria can be derived from the first order conditions corresponding to equations (13) and (14). As usual in a Cournot framework, identical players adopt identical strategies in equilibrium. Thus, I drop the subscript i for the AS type of firms. This yields

$$R_F = S_F = (a-m)(b+c)/((n-1)bc+d(b+c)) \tag{A.1}$$

$$P_F = (abc + ad(b+c) + 2bcnm)/((n+1)bc+d(b+c)) \tag{A.2}$$

and

$$R_C = (a-m)((2-n)b^2+bc+(2-n)bd+cd-(n-1)b^2d/c)/A \tag{A.3}$$

$$S_C = (a-m)(b^2+bc+2bd+b^2d/c+cd)/A \tag{A.4}$$

$$P_C = a - b(R_C+(n-1)S_C) \tag{A.5}$$

where

$$A = (n+1)b^2c+2b^3+(n+3)b^2d+b^3d/c+(n+2)bcd+cd^2 \\ +2bd^2+b^2d^2/c \tag{A.6}$$

Proposition 3: Comparing P_C and P_F is now straightforward. (Since it is quite tedious, the sceptical reader is advised to check the algebra using a computer program, such as e.g. *Mathematica*.) The solution is

$$P_C - P_F = b^3c(n-1)(a-m)(bc+bd+cd)/$$
$$[(bc+bd+cd+bcn)\,(2b^3c+b^2c^2+b^3d+3b^2cd+2bc^2d+b^2d^2+2bcd^2+c^2d^2$$
$$+b^2c^2n+b^2cdn+bc^2dn)]$$

which is always positive (remember; $a>m$). This establishes Proposition 3 part (i).

From (A.3) we see that the non-negativity constraint may bind if the countertrade agreement covers a large fraction of the market. The precise condition is found by checking when the numerator is negative (the denominator is always positive). It is assumed throughout the paper that $a>m$. Thus, in order to find a sufficient condition for an interior solution, we can focus on the terms (i) $(2-n)b^2+bc$ and (ii) $d[(2-n)b+c-(n-1)b^2/c]$. A sufficient condition for the first to be positive is that $c>(n-2)b$. In (ii) we can eliminate d (which is positive by assumption). Solving the second order polynomial, we find that a sufficient condition is that $c>(n-1)b$. This, then, is the stronger condition, which is easily translated into the requirement that $M_T<1/n$, proving Proposition 3 part (ii).

Proposition 1*: To find whether countertrade is rational, we must compute $D = \pi_{RC}(R_C,S_C) - \Delta - \pi_{RF}(R_F,S_F)$. If this expression is positive, we have from Observation 1 that countertrade is rational. Using *Mathematica* or some other program which performs symbolic manipulation (the task is almost impossible to perform by hand), it is found that the simplest form in which to express D is

$$D = \underset{(1)}{-b^7} + \underset{(2)}{4b^6k} + \underset{(3)}{2b^5dk} - \underset{(4)}{b^5k^2} + \underset{(5)}{b^4dk^2} - \underset{(6)}{b^3d^2k^2} - \underset{(7)}{6b^4k^3} - \underset{(8)}{13b^3dk^3} - \underset{(9)}{6b^2d^2k^3}$$

$$+ \underset{(10)}{4b^3k^4} + \underset{(11)}{10b^2dk^4} + \underset{(12)}{8bd^2k^4} + \underset{(13)}{2d^3k^4} + \underset{(14)}{3b^7n} + \underset{(15)}{2b^6dn} + \underset{(16)}{4b^6kn} - \underset{(17)}{2b^4d^2kn}$$

$$- \underset{(18)}{7b^5k^2n} - \underset{(19)}{26b^4dk^2n} - \underset{(20)}{13b^3d^2k^2n} + \underset{(21)}{4b^4k^3n} + \underset{(22)}{23b^3dk^3n} + \underset{(23)}{24b^2d^2k^3n}$$

$$+ \underset{(24)}{6bd^3k^3n} + \underset{(25)}{4b^3k^4n} + \underset{(26)}{6b^2dk^4n} + \underset{(27)}{2bd^2k^4n} - \underset{(28)}{b^7n^2} - \underset{(29)}{b^6dn^2} - \underset{(30)}{b^5d^2n^2}$$

$$- \underset{(31)}{2b^6kn^2} - \underset{(32)}{17b^5dkn^2} - \underset{(33)}{8b^4d^2kn^2} - \underset{(34)}{6b^5k^2n^2} + \underset{(35)}{17b^4dk^2n^2} + \underset{(36)}{26b^3d^2k^2n^2}$$

$$+ \underset{(37)}{6b^2d^3k^2n^2} + \underset{(38)}{14b^4k^3n^2} + \underset{(39)}{20b^3dk^3n^2} + \underset{(40)}{6b^2d^2k^3n^2} - \underset{(41)}{b^7n^3} - \underset{(42)}{4b^6dn^3}$$

$$- \underset{(43)}{b^5d^2n^3} - \underset{(44)}{8b^6kn^3} + \underset{(45)}{5b^5dkn^3} + \underset{(46)}{12b^4d^2kn^3} + \underset{(47)}{2b^3d^3kn^3} + \underset{(48)}{18b^5k^2n^3}$$

$$+ \underset{(49)}{24b^4dk^2n^3} + \underset{(50)}{6b^3d^2k^2n^3} - \underset{(51)}{2b^7n^4} + \underset{(52)}{b^6dn^4} + \underset{(53)}{2b^5d^2n^4} + \underset{(54)}{10b^6kn^4}$$

$$+ \underset{(55)}{12b^5dkn^4} + \underset{(56)}{2b^4d^2kn^4} + \underset{(57)}{2b^7n^5} + \underset{(58)}{2b^6dn^5}$$

where I have used the condition for an interior solution (Proposition 3 part (ii)) in setting $c=(n-1)b+k$. Thus, in evaluating the sign of D, we know that $b,d,k>0$ and $n\geq 2$. For simplicity, each term has been given a number. Proposition 1* can now be proved using the following table:

Positive term	Negative term	Residual	Number
(57)	(51)	$(n-1)2b^7n^4$	(59)*
(54)	(44)	$(10n-8)b^6kn^3$	(60)*
(53)	(43)	$(2n-1)b^5d^2n^3$	(61)*
(58)	(42)	$(n^2-2)2b^6dn^3$	(62)*
(59)	(41)	$(2n(n-1)-1)b^7n^3$	(63)*
(48)	(34)	$(18n-6)b^5k^2n^2$	(64)*
(46)	(33)	$(12n-8)b^4d^2kn^2$	(65)*
(55)	(32)	$(12n^2-17)b^5dkn^2$	(66)
(60)	(31)	$((10n-8)n-2)b^6kn^2$	(67)*
(61)	(30)	$(2n^2-n-1)b^5d^2n^2$	(68)
(62)	(29)	$(2n^3-4n-1)b^6dn^2$	(69)
(63)	(28)	$(2n^3-2n^2-n-1)b^7n^2$	(70)
(36)	(20)	$(2n-1)13b^3d^2k^2n$	(71)
(35)	(19)	$(17n-26)b^4dk^2n$	(72)
(64)	(18)	$((18n-6)n-7)b^5k^2n$	(73)*
(65)	(17)	$(12n^2-8n-2)b^4d^2kn$	(74)
(67)	(16)	$((10n-8)n^2-2n-4)b^6kn$	(75)
(40)	(9)	$(n^2-1)6b^2d^2k^3$	(76)
(22)	(8)	$(23n-13)b^3dk^3$	(77)
(21)	(7)	$(4n-6)b^4k^3$	(78)
(50)	(6)	$(6n^3-1)b^3d^2k^2$	(79)
(73)	(4)	$((18n-6)n^2-7n-1)b^5k^2$	(80)
(14)	(1)	$(3n-1)b^7$	(81)

*Used elsewhere in the table.

Table 2

In the second coloumn are all the negative terms in D. These are offset against the positive terms of the first coloumn, leaving a positive residual in the third coloumn. (The residual is written in a way so that it is easily seen to be positive if $n \geq 2$). This residual is given a number, and may be used to offset negative terms below in the table. The exercise shows that D is indeed positive, proving Proposition 1*.

To extend the proof to all continuous convex marginal cost functions, note that D is not a function of m. This means that - mathematically - we may well have marginal cost functions with a negative intercept. Consider now the case of a piece-wise linear marginal cost function, with each piece being steeper than the previous one (see figure 6). If the marginal cost function had been linear - given, say, by Y - we know that countertrade would have been profitable. The piece-wise linearity introduces two new possibilities. Let the marginal cost be given by the upper envelope of X and Y in figure 7.

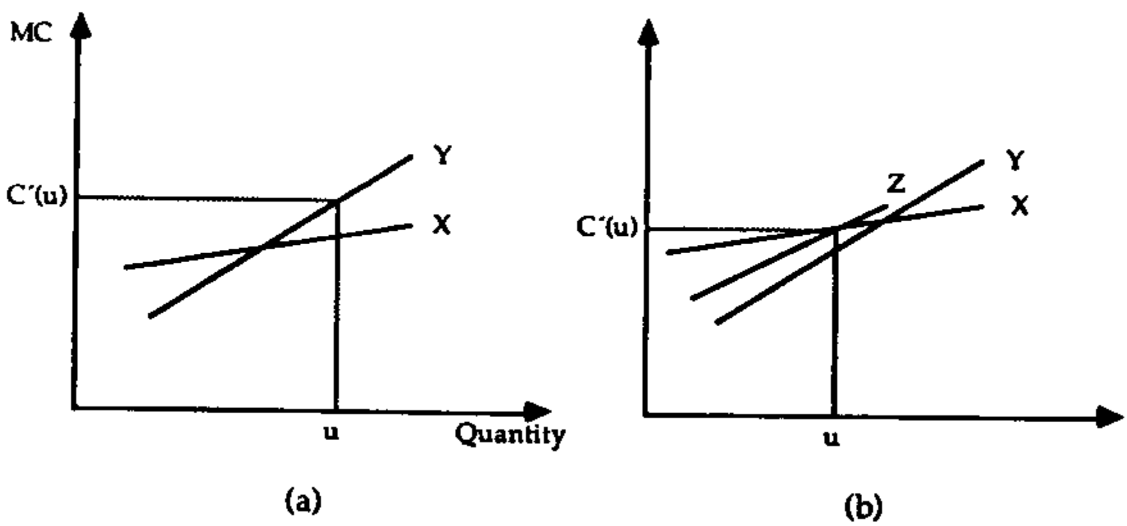

Figure 7

Case 1: Here, the output under no countertrade, denoted u, lies on the segment Y (see figure 7a). If countertrade does not induce AS to produce on the X segment of the marginal cost curve, nothing is changed. Suppose it does. Clearly, in this case AS is not going to compete more fiercely than if Y had been the marginal cost curve everywhere, as marginal cost is higher in the relevant range than before. Since the marginal cost of AR is not affected countertrade must be profitable. *Case 2*: Suppose now that the original output, u, was on the segment X (figure

7b). If countertrade does not induce AR to produce on the segment Y, we know that it is profitable. What if it does, and AR's output under countertrade is v, say? The trick is to compare this case with that where the marginal cost is Z, a straight line through u, with a slope less steep than that of Y, but sufficiently steep to cross Y above v. Now, apply the argument of case 1.

The proof is straightforwardly generalized to cost functions consisting of arbitrarily many linear segments and, consequently, the proposition must hold for any convex and continuous marginal cost function (because any such function can be arbitrarily closely approximated by a sufficiently fine piece-wise linear function).

<u>Proposition 2*.</u> The opponents gain if and only if $\pi_{SC}>\pi_{SF}$. The method of proof is to create a table like the one above, only bigger, and the full calculation is available from the author on request.

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