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RISK-SHARING IN INTERNATIONAL TRADE: AN ANALYSIS OF COUNTERTRADE

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Countertrade agreements in international trade refer to a trade practice in which an exporter agrees to purchase back commodities proportional to his original export sale in the future. The paper provides a rationale for why such an agreement might be efficient. More specifically, the paper argues that countertrade represents a rational response to market incompleteness by allowing the forward selling of commodities where no organized future market exists. This way countertrade helps to reduce risk by providing information on future market conditions and by offering insurance against random fluctuations in market conditions.

I. INTRODUCTION

COUNTERTRADE IS a tying contractual arrangement in international trade. In a typical countertrade transaction one party imports a product and the exporting party commits herself to purchase from the first party commodities equal to a portion of the original export value at a future point of time. The products that the exporting party purchases in the future to fulfil the countertrade obligation are specified in a shopping-list and each commodity flow is paid in foreign exchange, that is the two sides of the transaction are linked but financially separate. Since the exporting party—typically a firm in a western industrial country—commits herself to the purchase of commodities in the future, countertrade agreements are long term in nature with a time horizon of up to 10 years.[1]

Since the mid seventies countertrade has started to grow rapidly. Reasonable estimates range the phenomenon between 10 and 20 per cent of world trade (see OECD [1985], deMiramon [1985]). Besides the formerly centrally planned economies (CPEs), many of the developing countries (LDCs) have turned to countertrade in the belief that it facilitates economic development in face of an increased foreign indebtedness. The very fact that mostly countries with serious foreign-exchange shortages are engaged in

[1] The typical countertrade transaction is the counterpurchase form of countertrade. Counterpurchase accounts for 77 per cent of countertrade, while the other two forms of countertrade—barter and buy back—occur less frequently. They have a share in countertrade of 11 and 12 per cent, respectively, see Marin [1990]. Barter is—in contrast to counterpurchase—a spot transaction in which both commodity flows are exchanged at more or less the same time without the involvement of foreign exchange, while buy back is similar to counterpurchase with the commodity flows standing in a technical relation to each other; typically one flow consists of machinery and the other one of products produced with the machinery.

countertrade led to the most popular explanation of the phenomenon that countertrade helps to finance imports without the use of hard currency thereby allowing these countries to overcome the foreign-exchange constraint.[2] This paper argues that countertrade can be understood as a second-best outcome in the absence of complete risk and future markets. Faced with a tight foreign-exchange constraint the countries imposing countertrade have become more risk averse when deciding on future export areas. Given the constraint, these countries have felt the pressing need for a guarantee that future exports will generate the foreign-exchange earnings that they are now lacking. In the absence of adequate insurance markets these countries have looked for alternative ways to insure against the risk that they face and the paper views countertrade to be such a substitute for an absent futures market.[3] This explains also why countertrade has increased since the mid seventies when foreign debt and hard currency shortages have started to become particularly binding in these countries. Viewed in this way, it is not the need to finance imports when there is a hard currency shortage that accounts for the occurrence of countertrade but the increased risk aversion due to a tight foreign-exchange constraint that has created the incentive for countertrade as an insurance contract.

In previous papers (Marin [1991], and Caves and Marin [1992]) we have shown that barter can be explained by the presence of market distortions in the form of monopoly power of the western firm or in the form of price cartels and other collusive arrangements on the part of LDCs. In this paper we focus on market incompleteness in the form of the absence of perfect risk and insurance markets as a rationale for countertrade. Since risk allocation is our major concern in this paper we exclude other potential reasons for the choice of a tied contractual arrangement. More specifically, the paper ignores "relationship-specific investment" as factors giving rise to a tying relationship.[4] Moreover, the analysis does not take into account that most risk-sharing arrangements have significant effects on moral hazard incentives and involve adverse selection problems.[5]

The paper comes in four sections. Section II gives the model and section III looks at the optimal risk sharing properties determining the extent of price adjustment over time, and the share of production insured. Section IV undertakes some comparative statics with respect to changes in the amount of risk and risk aversion which shows how the model can explain the increase of

[2] The argument seems not convincing because among countertrade only barter avoids the usage of hard currency while counterpurchase and buy back involve foreign exchange in the transaction so that they cannot be effective in easing the foreign exchange constraint (see Banks [1983]).

[3] For an argument along similar lines see Parsons [1985].

[4] See Williamson [1985] and Klein, Crawford and Alchian [1978].

[5] We concentrate on moral hazard issues and *ex-post* hold up problems as an explanation for why countertrade as a tying arrangement might outperform non-tied trading arrangements in Marin and Schnitzer [1993].

countertrade in world trade observed since the mid seventies. Section V concludes. An appendix provides the proofs of the propositions made throughout the paper.

II. THE MODEL

Consider two agents: a firm DC in a western industrial country producing the good X which the firm wants to export to a CPE or a LDC, and a party called CPE being a firm or a Foreign Trade Organization (FTO) in a CPE or a LDC. The DC-firm faces an entry barrier in CPE's market and is willing to offer something in exchange to the CPE for helping her overcome this barrier. The CPE, in turn, deals with the following decision problem. Faced with a tight foreign exchange budget constraint CPE is highly risk averse when deciding on which products to produce for future exports. It will scrutinize carefully competing choices for the use of productive resources with respect to their prospects of generating future foreign exchange earnings. In this situation futures markets would be especially valuable to CPE since they would provide it with information on future market conditions for the product it considers producing and additionally would offer insurance against random fluctuations in price. Thus by selling the product forward, the CPE could eliminate all the risk from its foreign exchange earnings (in the absence of any supply risk) by having a guaranteed price over the period for which the futures market is open. This way futures markets guarantee that an investment today is generating foreign exchange earnings in the future thus making the present foreign exchange constraint less binding. In the absence of such perfect risk markets CPE will look for alternative ways to insure itself against the market risk it faces.[6] It will make DC's market entry contingent on DC's provision of a private futures market. It will negotiate with DC for a forward contract in which the DC-firm commits herself to purchase at a future date the product M that CPE considers to produce. If the DC-firm agrees to such a contract counterpurchase serves as an insurance against future price fluctuations and the fact that an agreement is reached will give CPE a signal on the future demand for the product.

CPE's utility function is given by

$$U_M = E[R_M] - C_M - \frac{A_M}{2}\sigma^2_{R_M} \tag{1}$$

with $E(R_M)$ as the expected total revenue and C_M total cost. CPE is assumed to be risk averse with A_M being the coefficient of absolute risk aversion and

[6] Future contracts exist only for a narrow range of commodities and most of them expire in six months or less. The reason why they are confined to a narrow range of commodities is that they require product quality to be exactly identified which is obviously only possible for standardized products. That more distant contracts do not exist might be associated with the increased costs of operating such markets which suggest that alternative risk-sharing arrangements, like long-term contracts or vertical integration, are less costly. For the reason why better futures markets do not exist see Newbery and Stiglitz [1985].

with $\sigma^2_{R_M}$ as the variance of R_M. When CPE signs a countertrade agreement its total revenue and costs become

$$R_M = \sum_{t=1}^{d} p_t^M \frac{M}{d} + \sum_{t=1}^{d} p_t \left[\frac{M^0}{T} - \frac{M}{d}\right] + \sum_{t=d+1}^{T} p_t \frac{M^0}{T}$$

$$C_M = p_x X + C_0 + C_T$$

with p_x the price for DC's product X in the countertrade agreement, p_t^M the countertrade price that DC agrees to pay for CPE's product M over the duration of contract d. p_t is the future spot world market price for M that CPE receives when it sells M in a traditional spot transaction. CPE incurs costs C_0 when it decides to produce M with M^0 being the total volume that can be produced over the production period T.

When CPE does a spot transaction its outside option revenue and costs are

$$R_M^0 = \sum_{t=1}^{T} p_t \frac{M^0}{T}$$

and

$$C_M^0 = p_x^c X + C_0$$

with p_x^c the price for DC's product X that the CPE pays in the spot transaction. Comparing revenues and costs under the two alternative arrangements, the CPE's benefit of signing a countertrade agreement relative to a spot transaction will depend on the difference between the countertrade price p_x^c and the spot price p_x for X, on the transaction costs of agreeing to the contract C_T, and on the extent to which the countertrade contract reduces the price risk that it faces. The risk reducing role of countertrade, in turn, will depend on the contract duration d relative to the gestation period T, on the reduction in price variability (the difference between $\sigma^2_{p_t^M}$ and $\sigma^2_{p_t}$), and on the share of production M/M^0 for which the contract provides insurance. In the absence of any supply risk, the CPE can eliminate all the risk from its foreign exchange earnings by signing a countertrade agreement with the features $d = T$, $\sigma^2_{p_t^M} = 0$, and $M = M^0$. In other words, the CPE will have shifted all the risk to the DC-firm when the contract extends over the total production period T and over the total volume of production M^0, and the DC-firm buys CPE's production at a fixed price. The CPE will pay for the risk reduction (elimination) in the form of a higher price p_x for X (whether DC will find such a contract acceptable will be dealt with below). Note that the specification of the utility function (1) leaves CPE the outside option of buying an identical good X from somebody else than DC without imposing a countertrade agreement and of producing M without any risk sharing arrangement when the expected revenues of the investment exceed the risk involved.[7]

[7] Since the analysis abstracts from moral hazard incentives and adverse selection problems it is assumed that CPE offers only one good M which has no quality dimensions and which is known to the DC-firm at the date of signing the contract.

The DC-firm's utility, in turn, is given by

$$U_X = E(R_X) - C_X - \frac{Ax}{2}\sigma^2_{R_X} \tag{2}$$

with $E(R_X)$ now DC's expected revenue, C_X her costs, and A_X the DC-firm's coefficient of absolute risk aversion. Under the countertrade contract the DC-firm's revenue and costs become

$$R_X = \sum_{t=1}^{d} (p_t - p_t^M)\frac{M}{d} + p_x X$$

and

$$C_X = c_x X + C_T$$

where c_x is DC's marginal costs. Under the spot transaction the DC-firm's revenue and costs are

$$R_X^0 = 0 \quad \text{and} \quad C_X^0 = 0$$

which reflects DC's entry barrier in CPE's market leaving her without an outside option to countertrade. DC's utility of signing a countertrade contract increases with the price-cost margin $p_x - c_x$ on X and with the possible profit that she makes when selling CPE's product—which depends on the expected value of the difference between the countertrade price p_t^M that DC pays to CPE for M and the price p_t that she gets when selling M on the world market. DC's profit of signing a countertrade agreement, however, decreases with the amount of risk that she agrees to bear—which depends on $\sigma^2_{(p_t - p_t^M)}$, the contract duration d, and the amount of M that she buys from CPE. Since the DC-firm faces an entry barrier in CPE's market the countertrade agreement can be viewed as an exchange of entry for a private futures market. It is assumed that DC is less risk averse than CPE, $A_X \leqslant A_M$ which is supposed to reflect the fact that DC being a firm in a market economy has more opportunities of risk spreading by, for example, reducing employment in a recession or going on the stock market than CPE who typically operates in a planned economy without any risk absorbing institutions.[8]

Furthermore, it is assumed that the spot world market price for M is generated by a random walk

$$p_t = p_{t-1} + u_t \quad \text{with} \quad u_t \, \text{iid}(0, \sigma_p) \tag{3}$$

The countertrade price p_t^M that DC pays for M is supposed to be determined by the following price rule

$$p_t^M = (1-\mu)p_t + \mu p_0 \qquad 0 \leqslant \mu \leqslant 1 \tag{4}$$

[8] For the attitudes towards risk in CPEs and its difference to western market economies see Kogut [1986].

with p_0 as the present and p_t the future spot world market price for M and μ as the risk shifting parameter. If $\mu = 1$ the countertrade agreement is a "fixed price contract" in which DC agrees to buy M at the world market price p_0 prevailing at the date of contract agreement and remaining unchanged over contract duration while with $\mu = 0$, DC pays the price prevailing on the spot market for the countertrade good at the date of delivery which is referred to as a "spot price contract." For given d and M, the "fixed price contract" allocates all the risk to DC while in the "spot price contract" all the risk of future price variability remains with M. Any value of μ between 0 and 1 therefore describes a situation of risk sharing between DC and CPE.

III. OPTIMAL RISK SHARING PROPERTIES

In this section we determine the amount of price and output insurance that CPE will obtain from the DC-firm. DC and CPE will extend the contract over the whole gestation period of the investment, since the gains from risk sharing are maximized at this contract length.[9]

We assume a symmetric situation between DC and CPE and use the Nash Bargaining as a benchmark case in modeling the bargaining. The bargaining is a one shot game under complete information in which both DC and CPE simultaneously make an offer and an agreement is reached if both offers are compatible with each other.[10] We assume that $\sigma_p = 1$, $A_X = 1$, $A_M = \alpha > 1$, $\theta = p_0 M^0$ and $s = p_X X = p_0 M$. Furthermore, the two restrictions $d \leqslant T$, $\frac{M}{d} \leqslant \frac{M^0}{T}$ are assumed to hold; that is contract duration cannot exceed the gestation period of the investment T and CPE cannot deliver more than it produces. Since both DC and CPE have a common interest to extend the contract over the whole gestation period $d^* = T$, the bargaining over risk sharing takes place only with respect to μ and s. Normalizing U_M to 0, substituting (4) into (1) and (2) and taking expected values, the two utility functions rewrite then to

$$(1'') \qquad U_M = c_1 - s - \alpha_M(\Theta - \mu s)^2$$

$$(2'') \qquad U_X = -c_2 + s - \alpha_X(\mu s)^2$$

[9] For a proof that $d^* = T$ see Amann and Marin [1990].

[10] In a typical countertrade deal DC has the option of leaving the contract commitment by paying a penalty to CPE. In our model, however, DC is not free to leave the commitment once she has agreed to the contract. Thus we have made the assumption that the penalty costs of breaking the contract are infinite. This assumption can be justified by the fact that in reality the parties play repeated games in the form of having a continuous business relationship which prevents them from breaching. Breaking the contract for short run profit opportunities would upset future business terms thereby making the effective penalty costs very high. For empirical evidence supporting this see Marin [1990]. For a descriptive representation of countertrade deals see OECD [1981, 1985], Group of Thirty [1985] and Korth [1987].

with

$$c_1 = \min\{\Theta - C_0, \textstyle\sum_M\} + p_X^c X$$

$$c_2 = \qquad\qquad c_X X$$

$$\alpha_M = \frac{A_M}{2p_0^2}\frac{(2T+1)(T+1)}{6T}$$

$$\alpha_X = \frac{1}{2p_0^2}\frac{(2T+1)(T+1)}{6T}$$

where $\alpha_M \Theta^2 = \sum_M$

In the Nash Bargaining solution $W = (U_X - U_X^0)(U_M - U_M^0)$ is maximized which reflects the symmetry between DC and CPE. In order to find the optimal amount of insurance that DC provides to CPE the problem max W over μ and s is solved.[11]

Proposition 1. The optimal risk sharing properties with respect to μ and s are given by

$$\mu s = \left[\frac{\alpha_M}{(\alpha_X + \alpha_M)}\right]\Theta \tag{5}$$

which implies

$$\frac{\delta U_M}{\delta s} = \frac{-\delta U_X}{\delta s} \quad \text{and} \quad \frac{\delta U_M}{\delta \mu} = \frac{-\delta U_X}{\delta \mu}$$

Proof. in the Appendix

Proposition 1 states that the optimum amount of insurance that DC provides to CPE will depend on relative risk aversion only. If $\alpha_X = \alpha_M$, that is DC and CPE do not differ in their attitude towards risk, then the insurance covers a half of CPE's total production, while if DC is risk neutral, $\alpha_X = 0$, equation (5) (subsequently denoted by C_p) implies that DC insures CPE's total production and thus bears all the risk. C_p describes the loci of Pareto optimal risk sharing outcomes. At all points on the C_p curve DC's and CPE's indifference curves are tangential to each other reflecting that neither DC nor CPE can improve his/her utility through a change in s and/or μ without making the other worse off. A further implication of optimal risk sharing is that DC's and CPE's marginal rates of substitution of μ and s are equal. In other words, any increase in DC's utility through a marginal change in s and μ will be just offset by a decline in CPE's utility.

[11] For the concept of Nash Bargaining see van Damme [1987].

Proposition 2. If a Nash Bargaining solution exists in the interior of the strategy space $S = [0,1] \times [0,\Theta]$ it will have the property of $(s,\mu) \in C_P$ and $U_X = U_M$.

Proof. in the Appendix

A geometrical illustration of Proposition 2 is given in Figure 1. In the (μ, s)-space the curve C_P is drawn which reflects the loci of Pareto optimal risk sharing outcomes. Furthermore, the figure shows three distinct indifference curves. The $U_X = 0$ and the $U_M = 0$ curves showing the (μ, s)-combinations at which DC's and CPE's utility, respectively, are zero and the $U_X = U_M$ curve giving the loci of equal splitting of the pie between DC and CPE. Any right downwards shift of the U_X = constant curve represents a higher utility level to DC since her benefit of signing the contract increases with lower μ and higher s, while any left upwards shift of CPE's indifference curve indicates an increase in CPE's payoff. The point E_M (the intersection between the $U_X = 0$ and the C_P curve) reflects an equilibrium outcome when CPE is a powerful FTO that moves first and gets the maximum risk reduction at which DC will still agree to the contract. The Nash Bargaining solution is illustrated by point E which is given by the intersection of the $U_X = U_M$ and the C_P curve.

The optimum amount of output insurance that CPE obtains in the Nash Bargaining is given by[12]

$$(6) \qquad (s^* - c_2) = \frac{(c_1 - c_2)}{2} + \frac{(\alpha_M - \alpha_X)}{2}\left[\frac{(\alpha_M \alpha_X)}{(\alpha_M + \alpha_X)^2}\right]\sum\nolimits_M$$

$$= \frac{(c_1 - c_2)}{2} + \frac{(\alpha_M - \alpha_X)}{2}\sum\nolimits_X$$

that is the optimal price s^* that CPE will pay for X will be such as to cover the risk costs $\sum_X$ that accrue to DC when she agrees to the contract $d^* = T$ and μ^* and, furthermore, the price will be such as to allocate half of the profits and half of the gains from risk sharing to X. Consider each of the right hand side expression of equation (6) separately. DC's risk cost $\sum_X$ will depend on the size of the original risk $\sum_M$ and on the difference in risk aversion between DC and CPE. If DC and CPE do not differ in their attitude towards risk, $\alpha_X = \alpha_M$, then DC's risk cost will be $1/4\sum_M$, that is DC will need to be compensated for a quarter of the original risk. The reason why DC's risk costs are only a quarter of CPE's original risk is that the insurance generates an externality in the form of gains from risk spreading as the risk is now shared between DC and CPE instead of borne by CPE alone. If $\alpha_X < \alpha_M$, that is DC is less risk averse than CPE, DC requires a smaller compensation for providing the risk market because of the following two reasons. One reason is that DC does not

[12] s determines M and thus the share of CPE's production insured because of the assumption of $s = p_X X = p_0 M$ making $M = s/p_0$ when setting $X = 1$.

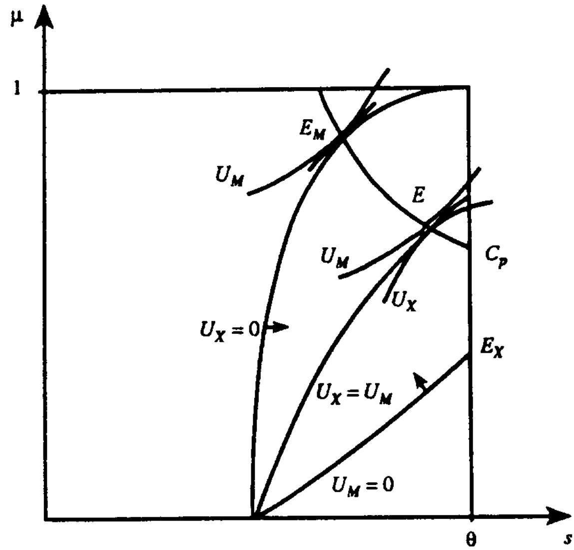

Figure 1
Optimal Risk Sharing

mind the risk as much as CPE which reduces the price that she asks for providing the insurance which is reflected in $\alpha_M\alpha_X/(\alpha_M+\alpha_X)^2 < 1/4$ when $\alpha_X < \alpha_M$. The second reason is that there are additional gains from risk sharing when $\alpha_X < \alpha_M$ since the contract allocates some of the risk to DC who cares less about it. These additional gains from risk sharing are divided equally between DC and CPE in the Nash Bargaining which is expressed by the term $1/2(\alpha_M-\alpha_X)$ in equation (6). Finally, the optimal price for X will depend on the level of profits c_1-c_2 that both agents earn in the transaction since in the Nash Bargaining these profits are split equally between them. This implies that the more (less) profitable the production of M the higher (lower) will s^* be while the reverse is the case for different sizes of DC's profit margin. s^* will be the lower the more monopoly power DC usually has in traditional transactions. Note that when the bargaining power of the agents is not as symmetric as the Nash Bargaining assumes but CPE is a powerful FTO making the offer of μ and s, then (6) reduces to $s^*-c_2 = \sum_X$ implying that the price will just cover the risk that DC takes when supplying the futures market to CPE (this corresponds to the equilibrium point E_M shown in Figure 1).[13] The optimum amount of price insurance μ^* that corresponds to s^* is

[13] When $\alpha_X = \alpha_M$ equation (6) becomes $s^*-c_2 = (c_1-c_2)/2$ with $(c_1-c_2)/2 > \alpha\Theta^2/4$ reflecting that in this case the profits that are earned by both agents cover DC's risk cost $\sum_X = \alpha\Theta^2/4$ and the remaining profits are equally divided between them.

determined by

$$(7) \qquad \mu^* = \left[\frac{\alpha_M}{(\alpha_M + \alpha_X)}\right]\frac{\Theta}{s^*}$$

The higher the share of production for which the contract provides insurance s^*/Θ, and the smaller the difference in risk aversion between DC and CPE, the more will the contract need to look like a spot price contract (the smaller will μ need to be) in order to make DC accept the agreement. Note that the greater (lower) CPE's bargaining power the more (less) will the contract look like a fixed price contract as CPE will be able to achieve more price insurance at lower costs (compare equation (6) and (7) and the outcomes E_M and E in Figure 1).

IV. COMPARATIVE STATICS

In this section we undertake some comparative statics in order to see how changes in risk or risk aversion will affect the insurance features of the contract. Furthermore, we explore whether the gains from counterpurchase increase with larger risk aversion and thus look at whether the prediction of the model is consistent with our hypothesis that countertrade has increased since the mid seventies because the risk aversion of the CPEs and LDCs have increased in face of a tight foreign exchange constraint.

Consider Figure 2a for the effect of a change in the amount of risk on the

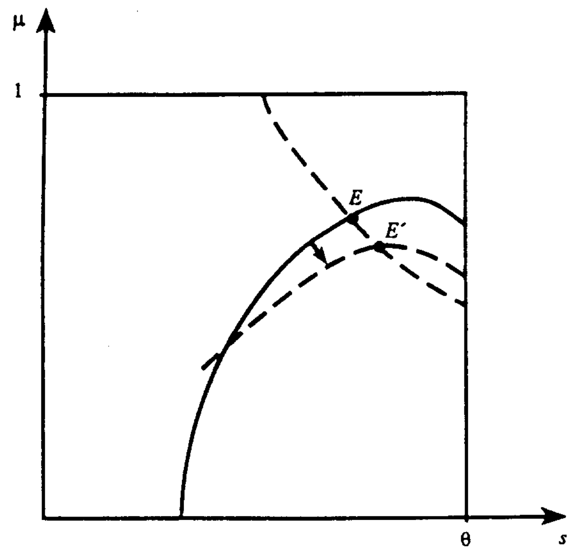

Figure 2a
Comparative Statics: $\Delta\sigma_p^2$

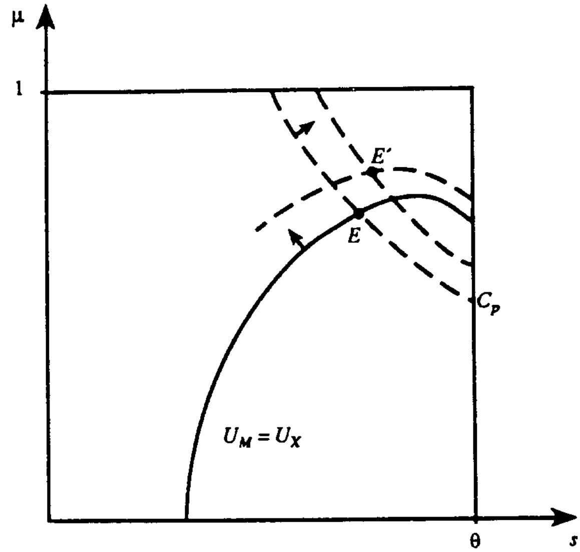

Figure 2b
Comparative Statics: ΔA_M

insurance features of the countertrade contract. Suppose that the amount of risk σ_p^2 increases and suppose further that DC's and CPE's attitude towards risk is not affected by this change in risk leaving A_M/A_X constant. A change in σ_p^2 leaves the C_P curve that describes the loci of Pareto optimal risk sharing unchanged since the Pareto outcomes depend on relative risk aversion only. An increase in σ_p^2 will shift the $U_X = U_M$ curve downwards as DC takes disproportionally more of the risk when she is less risk averse than CPE. In order for the utilities of both agents to remain the same CPE will need to pay a higher price for the insurance while getting a smaller amount of price insurance. Thus, an increase in risk will make the contract look more like a spot price contract and will require CPE to pay more for an insurance with less risk absorption. Figure 2b illustrates how the picture looks when CPE's risk aversion increases. An increase in A_M will shift the C_p curve upwards since the increase in relative risk aversion will now require DC to take a greater amount of risk from CPE in order for the gains from risk sharing to be maximized. The $U_X = U_M$ curve, in turn, will also shift upwards since CPE's greater risk aversion now means a lower benefit to him from the agreement requiring DC to compensate CPE for this loss in utility by offering more price insurance. s will also increase in response to the change in A_M because CPE is willing to pay more for a greater amount of price insurance or because CPE will want more output insurance when the amount of price insurance has increased. Thus, an increase in A_M will increase the amount of price and output insurance that CPE will receive in the contract.

In order to assess how the gains from countertrade are affected by an increase in CPE's risk aversion we distinguish two cases since the result depends critically on whether or not producing M is profitable without a risk sharing contract.

Case 1. $\Theta - C_0 > \sum_M$ that is the production of M is profitable without the countertrade insurance. In this case countertrade (CT) will increase in response to CPE's higher risk aversion. The first derivative of the gains from countertrade with respect to A_M is[14]

$$\frac{\delta CT}{\delta A_M} = \left[\frac{A_M^2}{(A_M + A_X)}\right]^2 \frac{\sum_M}{A_M} > 0$$

Case 2. $\Theta - C_0 < \sum_M$ that is the production of M is not profitable without the countertrade contract. In this case countertrade will decrease in response to an increase in A_M since

$$\frac{\delta CT}{\delta A_M} = \left[\frac{-A_X^2}{(A_M + A_X)^2}\right] \frac{\sum_M}{A_M} < 0$$

The reason for this result is as follows. When producing M is profitable without the insurance an increase in A_M makes the difference in risk aversion between DC and CPE larger which increases the gains from risk sharing stemming from the efficiency that arises when some of the risk is transferred to someone who cares less about it. However, when the production of M is not profitable without the insurance then an increase in A_M will lead merely to an increase in the costs of risk making CPE more reluctant to produce M in the countertrade contract. In other words, an increase in CPE's risk aversion makes the size of the pie larger when the production of M is profitable without any risk sharing arrangement, while it makes the size of the pie smaller when producing M is not profitable without an insurance. Thus, as long as the CPEs/LDCs produce goods with sufficiently high profits, an increase in their risk aversion will increase their demand for countertrade as additional gains from risk sharing can be exploited. This increase in risk aversion is our main explanation for why countertrade has increased since the mid seventies.[15]

V. CONCLUSIONS

In this paper we have developed a model explaining risk sharing arrange-

[14] The gains from countertrade are $(p_X^c - c_X)X + \min\{\Theta - C_0, \sum_M\} \geqslant \frac{A_X}{(A_X + A_M)} \sum_M + C_T$.

[15] From this follows that we expect these countries' demand for countertrade to decline with the reduction of their foreign debt. This result contradicts the view of international organizations who see countertrade to have increased because the CPEs/LDCs have increasingly become unable to earn sufficient foreign exchange in order to finance their imports and therefore are seen to use countertrade to export goods which they cannot export otherwise. See OECD [1981].

ments in international trade which play an especially important role in East–West trade and in trade with Developing Countries. The paper shows that countertrade contracts can be seen as a substitute for an absent futures market and, thus, as a second-best outcome when markets are incomplete. The model predicts that the agreement will tend to be a fixed price contract the smaller the risk is, the more the two parties differ in their attitude towards risk, and the more monopoly power the DC firm has in traditional transactions making the western firm which provides the insurance more willing to absorb a greater amount of risk at a price that the CPEs/LDCs are willing to accept. Finally, the model shows that the increase of countertrade in world trade observed since the mid seventies can be attributed to an increase in risk aversion of the CPEs/LDCs in face of a tight foreign exchange constraint.

By leading to more export stability countertrade might have promoted growth in the CPEs/LDCs.

A sufficient condition for countertrade to have a positive impact on the rate of investment and thus on the rate of growth is

$$\frac{A_X}{(A_X+A_M)}\sum_M + C_T < \Theta - C_0 < \sum_M .$$

Countertrade will benefit the CPEs/LDCs in the form of higher investment when the investment becomes profitable under the risk sharing contract only. The reason why the investment might become profitable under countertrade when not being profitable without it is that the contract ties together two functions—the exporting of the good on the one hand and the provision of the insurance on the other. This way countertrade might accelerate investment and, thus, growth through export-led stability.[16]

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[16] Whether more or less export stability will stimulate investment and growth is an open question, see Knudsen and Parnes [1975], Newbery and Stiglitz [1985].

APPENDIX

Proposition 1. The optimal risk sharing properties are given by

$$(1) \qquad s\mu = \frac{A_M}{A_M + A_X}\theta$$

Proof. CPE's and DC's indifference curves are determined by:

$$I_M: -1 + 2\alpha_M(\theta - s\mu)(\mu + s\mu'_M) = 0$$

$$I_X: 1 - 2\alpha_X s\mu(\mu + s\mu'_X) = 0$$

implying that $\mu + s\mu' > 0$. They are tangential to each other if and only if

$$2\alpha_M(\theta - s\mu) = 2\alpha_X s\mu$$

$$s\mu \lesseqgtr \frac{A_M}{A_M + A_X}\theta \Rightarrow \mu_M \lesseqgtr \mu_X \Rightarrow$$

there are Pareto improvements towards an increase (decrease) of μs. By the fact that $\alpha_M/(\alpha_M + \alpha_X) = A_M/(A_M + A_X)$ we get the desired result. □

Corollary 1. The utility of player CPE (DC) on the Pareto curve is monotonically increasing (decreasing) in μ. It is moreover linear in the interior of the strategy space $S = [0, 1] \times [0, \theta]$.

$$U_M = c_1 - s - \alpha_M\left(\frac{A_X}{A_X + A_M}\theta\right)^2$$

$$U_X = s - c_2 - \alpha_X\left(\frac{A_M}{A_X + A_M}\theta\right)^2$$

Remark: On the loci of the Pareto optima the division of the risk and thus $U_M + U_X$ remain constant.

Proposition 2. If there exists a Nash bargaining solution in interior S then it is determined by

$$(s, \mu) \in C_P$$

where C_P stands for Pareto Curve and

$$U_M = U_X$$

Proof. The first condition follows immediately. By Corollary 1 the Nash bargaining solution which is defined by $\arg\max U_M . U_X$, maximizes

$$(\text{const.}_M - s)(s - \text{const.}_X)$$

The first order condition gives

$$s = \frac{\text{const.}_M - \text{const.}_X}{2}$$ □

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