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OPTIMAL RULES FOR CARTEL MANAGERS WITH EMPIRICAL APPLICATIONS TO THE COPPER AND TEA MARKETS

BY JOHN UNDERWOOD*

This study develops a framework for measuring the expected gain to members of a primary-commodity producer cartel. Dynamic world commodity market models are used in a stochastic control setting to calculate the expected gain to members of tea and copper cartels. On the basis of present discounted value of export earnings, a tea cartel would have a borderline chance of success, while chances for a copper cartel (not including the U.S. and/or Canada) would appear slim.

1. INTRODUCTION

OPEC oil exports jumped from \$21.1 billion in 1971 to \$120.9 billion in 1974.[1] Assuming that the OPEC import price index increased by 20 per cent per year, the 1974 oil export earnings of OPEC in 1971 dollars were about \$70 billion, so that the real oil earnings of OPEC members more than tripled. Will other primary commodity producer groups be equally successful?[2]

The purpose of this study is to develop a framework within which to measure, at least to a first approximation, the expected gain to the members of a primary commodity producer cartel. Then, that framework is used to estimate the potential gain to cartelization for two primary commodities, tea and copper. Dynamic world commodity market models are used in a stochastic control setting to calculate the expected gain to the members of tea and copper cartels.

As is usually the case in narrowing the scope of study, some potentially important problems are ignored here. No attempt is made to calculate the optimal timetable for cartel formation or duration. The problems involved in maintaining a cartel as well as the potential effects of consumer retaliation are ignored. These are serious and interesting questions and constitute topics for further research. However, a large expected return is almost certainly a necessary (but not sufficient) condition for the

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[1]Sources: IMF, *International Financial Statistics*, April, 1973 and April, 1976, and IBRD, *Commodity Trade and Price Trends*, 1975.

[2]Several authors have discussed the possibility of success of other primary producer cartels. See, for example, Bergsten (1973 and 1974), Varon and Takeuchi, (1974) and Stern and Tims (1975).

formation of a successful cartel. Here, we are looking to see if this condition is met in two commodity markets under a certain set of assumptions about the nature of those markets.

II. Model and Method

A. *Welfare Measure and Control Variable*

The welfare measure chosen for use here is the present discounted value of export earnings. Some justification for using this measure must be given since resources are employed in earning foreign exchange. Johnson (1967, p. 156) has provided a compelling argument. He notes that it is impossible to ascertain whether less developed countries are over- or under-exploiting their monopoly power in commodities with elastic demands, while they must be under-exploiting it for commodities with inelastic demands in the current price range. He then concludes that, pending further research, one ought to accept maximization of foreign exchange earnings as a safe minimal standard for optimal commodity agreement policy and inelasticity of demand at current prices as a criterion for selection of commodities for agreements.

The control variable used is an export tax, which is assumed to be uniform across countries. Negotiations among producer countries would be more likely to result in such a tax than in a different export tax for each country, even though the expected gain is smaller than it would be using country-specific taxes. The export tax increases expected export earnings when the net demand curve faced by the cartel is price inelastic.

B. *Control Framework*

The commodity market models (linear with addative error terms) are put into the following framework:

$$H^* x_t^* + J^* x_{t-1}^* + M^* u_t + L y_t = e_t^* \tag{1}$$

where x_t^* is the vector of endogenous variables, y_t is the vector of exogenous variables,[3] u_t is the scalar control variable (the export tax) and e_t^* is the vector of error terms. The estimated coefficients (H^*, J^*, M^*, L) are assumed to be known with certainty. e_t^* is assumed to be a vector of random variables with zero means and variances equal to the estimated variances. Each exogenous variable is assumed to follow a first-order autoregressive process of the form:

[3]Exogenous variables are mainly GNP's, industrial production indices and population variables.

$$Y_t^i = a^i Y_{t-1} + r_t^i$$ [4]

where Y_t^i is a scalar and r_t^i is a serially uncorrelated error term with mean zero. Coefficients a^i were estimated by ordinary least squares. Again the estimated a^i are assumed to be known with certainty and the variance of each r^i equal to the estimated variance. In vector form:

(2) $$y_t - A^* y_{t-1} = R_t.$$

Using equations (1) and (2), we can incorporate x_t^* and y_t into a single vector of endogenous variables, x_t. This gives us:

(3) $$Hx_t + Jx_{t-1} + Mu_t = e_t$$

where:

$$x_t = \begin{bmatrix} x_t^* \\ y_t \end{bmatrix};\ H = \begin{bmatrix} H^* & L \\ 0 & I \end{bmatrix};\ J = \begin{bmatrix} J^* & 0 \\ 0 & -A^* \end{bmatrix};\ M = \begin{bmatrix} M^* \\ 0 \end{bmatrix};\ e_t = \begin{bmatrix} e_t^* \\ R_t \end{bmatrix}$$

Since H is known and nonsingular, we can multiply both sides of (3) by H^{-1}. The resulting equation is written as:

(4) $$x_t = Ax_{t-1} + Bu_t + V_t$$

The present discounted value of the cartel members' export earnings can be expressed as

(5) $$\sum_{t=1}^{T} x_t' K_t x_t$$

where $K_t = d^t K$ and d is the discount factor. K is a symmetric matrix consisting of zeros except for certain off-diagonal elements, which are either 1/2 for each element which becomes the coefficient of the product of the price and a cartel member's production or $-1/2$ for each element which becomes the coefficient of the product of the price and a cartel member's consumption. Since each of these products appears twice, the resulting sum is the yearly export earnings of the cartel countries.

Standard "certainty equivalence" stochastic control techniques[5] can be applied to equation (4) and (5) to calculate the maximal expected return to a cartel. The expected value of export earnings without a cartel is calculated by setting $u_t = 0$ for all t, $t = 1, \ldots T$. The difference between these two values is the expected gain in export earnings due to the proposed cartel.

Some of the equations in the copper and tea models were thought to have autocorrelated error terms. By applying a transformation similar

[4]These equations were estimated without constant terms.
[5]See, for example, Chow (1975), pp. 173 174, 176 182.

to the standard autoregressive transformation in econometrics,[6] a new vector stochastic first order difference equation with known parameters and serially uncorrelated error terms can be derived.

C. *The Commodity Market Models*

The selection of a commodity for application of the optimal control technique was made with certain desirable attributes in mind. The commodity should be produced mainly in less-developed countries (LDC's). LDC's have displayed the most interest in such cartels. Also, the welfare measure (present discounted value of export earnings) was chosen with LDC's in mind. For a commodity to be of interest, short-run demand ought to be inelastic at current prices, given the welfare measure. To facilitate the formation and maintenance of an actual cartel, there should be few producer countries and few or no potential large entrants.

There also had to be enough data available for estimation of a world market model for any commodity studied. Ideally, one would like an acceptable, already estimated linear world market model which would immediately fit into the framework outlined in the previous section.

These criteria were most nearly met for two commodities, tea and copper. There was an easily accessable copper market model[7] which needed little adjustment to fit into the quadratic-linear framework described above. That model (like the tea model used) is, for reasons of data availability, an annual one. Several equations were re-estimated using a slightly different form. The linearized version of the copper model used in calculating the expected return to a cartel is given below.[8,9]

There are primary supply (mine production) equations for the major producer countries or areas, the United States, Canada, Zambia, Chile and the rest of the world.

(C1)

$$MP_t^{US} = -185.8 + 0.7682PCU_t^{EMJ} + 0.6665MP_{t-1}^{US} + 0.4e_{t-1}^{USP} + \delta_t^{USP}$$

(C2)

$$MP_t^{C} = -39.62 + 0.08662PCU_t^{EMJ} + 0.9782MP_{t-1}^{C} - 0.4e_{t-1}^{C} + \delta_t^{C}$$

[6] Assuming that the estimated coefficients of autocorrelation are the true ones, we have $e_t = A e_{t-1} + \delta_t$ where A has zeros off the diagonal and δ_t is a vector of serially uncorrelated error terms with mean zero. Using this equation together with (4), the system can easily be transformed into one having serially uncorrelated error terms. x_t is augmented by x_{t-1} and u_t See Underwood (1976), pp. 70 71.

[7] See Fisher, Cootner and Baily (1972). It is a model only of the copper market in Western countries. Eastern Bloc consumption, production and trade are ignored.

[8] For complete econometric results, see Fisher, Cootner and Baily (1972) and Underwood (1976).

[9] By assuming that "purchasing power parity" holds, we can write all prices in terms of 1967 U.S. dollars per metric ton. Quantity variables are in units of millions of metric tons

(C3)

$$MP_t^Z = 16.1 + 0.01536PCU_t^{LME} + 0.9477MP_{t-1}^Z - 0.1e_{t-1}^Z + \delta_t^Z$$

(C4)

$$MP_t^{CH} = -54.52 + 0.1334PCU_t^{EMJ} + 0.9477MP_{t-1}^{CH} - 0.2e_{t-1}^{CH} + \delta_t^{CH}$$

(C5)

$$MP_t^{RW} = -28.13 + 0.2248PCU_t^{EMJ} + 0.8836MP_{t-1}^{RW} - 0.5e_{t-1}^{RW} + \delta_t^{RWP}$$

These were estimated as "stock adjustment" type mine production (MP) equations. Primary copper in the U.S., Canada and, for the most part, Chile moved at the U.S. producers' price during the period of estimation. This price tends generally toward the London Metal Exchange (LME) price but is set by major U.S. producers and is often unchanged for weeks or even months.[10] A price representative of the producers' price (but adjusted for the small fraction of primary copper in the U.S. that moves at the LME price) is taken from the *Engineering and Mining Journal* (EMJ). The copper primary supply equations are generally characterized by low speeds of adjustment, as shown by the coefficients of lagged mine production.

Three secondary supply equations are estimated, production from old and new scrap in the United States and total production from scrap for the rest of the world.

(C6) $$OS_t^{US} = 329.5 + 0.1055PCU_t^{LME} + e_t^{OS}$$

(C7) $$NS_t^{US} = -196.1 + 0.3649DC_t^{US} + e_t^{NS}$$

(C8) $$SC_t^{RW} = -655.6 + 0.1423PCU_t^{LME} + 0.02677K_t^{RW} - 0.04846SC_{t-1}^{RW} + 0.4e_{t-1}^{SC} + \delta_t^{SC}$$

No significant price effect was found in the equation for the production of copper from new scrap (scrap generated in the production of copper products). K^{RW} is a measure of the total amount of copper available for collection in rest of the world. A similar variable constructed for the United States was not found to be significant in a linear equation for copper production from old scrap. The U.S. scrap market price moves closely with the LME price.

Copper consumption (DC) equations were estimated for four areas, the U.S., Western Europe, Japan and the rest of the world.

[10] See Fisher, Cootner and Baily (1972), pp. 571–573 for a discussion of the two-price system in the world copper market.

(C9)

$$DC_t^{US} = 0.2414 - 0.3808PCU_t^{EMJ} + 0.04589PA_t^{US} + 3.6701I_t^{US} + 69.691D^{US} - 136.61D_{t-1}^{US} + 66.941D_{t-2}^{US} + 0.9552DC_{t-1}^{US} - 0.4e_{t-1}^{USC} + \delta_t^{USC}$$

(C10)

$$DC_t^{E} = -1{,}220 - 0.2714PCU_{t-1}^{LME} + 2.830PA_{t-1}^{US} + 9.045I_t^{E} + 0.5426DC_{t-1}^{E} - 0.1e_{t-1}^{E} + \delta_t^{E}$$

(C11)

$$DC_t^{J} = 153.7 - 0.1357PCU_t^{LME} + 1.783I_t^{E} + e_t^{J}$$

(C12)

$$DC_t^{RW} = -171.6 - 0.09432PCU_t^{LME} + 0.2444PA_t^{US} + 6.75I_t^{RW} - 0.01969DC_{t-1}^{RW} + 0.4e_{t-1}^{RWC} + \delta_t^{RWC}$$

The consumption equations, except for Japan,[11] are also postulated to be of the "stock adjustment" form. Besides the price of copper, the most important determinants of the demand for copper are industrial production (in index form: I) and the price of its main substitute, aluminum (PA). Current and lagged real values of inventories of durable goods (ID) are used in the U.S. equation to capture the change in copper inventories held as finished goods. Data problems prevented the use of inventory variables in other consumption equations.

Three price equations were estimated:

(C13)

$$PCU_t^{EMJ} = 0.9763PCU_t^{PR} + 0.1534PCU_t^{LME} + e_t^{EMJ}$$

(C14)

$$PCU_t^{PR} = 277.5 - 0.8298STC_{t-1}^{US} + 0.8298STC_{t-2}^{US} + 0.01726DC_{t-1}^{US} + 0.2694PCU_{t-1}^{LME} + 0.3289PCU_{t-1}^{PR} + 0.2e_{t-1}^{PR} + \delta_t^{PR}$$

(C15)

$$PCU_t^{LME} = -784.1 - 0.6204STC_t^{RW} + 23.00I_t^{RW} + 0.2214PCU_{t-1}^{LME} + 0.5e_{t-1}^{LME} + \delta_t^{LME}$$

The EMJ price is estimated as a function of the U.S. producers' (PR) price and the LME price. U.S. producers are assumed to adjust their prices based on the level of consumption and the change in stocks levels (STC) in the U.S. and on last year's LME price. This price, on the

[11] No evidence of a lagged adjustment process could be found for Japan.

other hand, is basically a free market price. It is determined simultaneously with the other variables in the model.

An equation is also estimated to explain U.S. imports:

(C16)

$$X_t = -131.3 + 0.6291(PCU_t^{PR} - PCU_t^{LME}) + 0.3122(DC_t^{US} - MP_t^{US}) + 0.4e_{t-1}^{X} + \delta_t^{X}$$

The obvious identities close the model. The price of aluminum is taken as exogenous, as is the price of coffee in the tea model. This is certainly not the case; however, it would be a monumental task to create and estimate useful aluminum and coffee models in order to make these prices endogenous.

The world tea market model presented here is more loosely based on an earlier model.[12] It represents the world black tea market. However, exports from the green tea producing and consuming areas, mainly China and Japan, are included in "rest-of-world production." Net imports of black tea into the Eastern Bloc are included in "rest-of-world" consumption.[13,14]

Partial adjustment supply equations were estimated for India, Sri Lanka, East Africa and the rest of the world:

(T1)

$$S_t^{I} = -2{,}192 + 320{,}900PT_t^{US} + 0.9495S_{t-1}^{I} - 0.5e_{t-1}^{SI} + \delta_t^{SI}$$

(T2)

$$S_t^{SL} = 7{,}279 + 142{,}500PT_t^{US} + 0.8988S_{t-1}^{SL} - 0.4e_{t-1}^{SL} + \delta_t^{SL}$$

(T3)

$$S_t^{EA} = 3{,}006 + 27{,}041PT_t^{US} + 1.093S_{t-1}^{EA} - 0.9e_{t-1}^{EA} + \delta_t^{EA}$$

(T4)

$$S_t^{RW} = -39{,}390 + 608{,}100PT_t^{US} + 0.8344S_{t-1}^{RW} + 0.4e_{t-1}^{RWS} + \delta_t^{RWS}$$

The coefficients of lagged supply are close to unity, indicating a slow rate of adjustment of output to a price change. For East Africa, this coefficient is greater than one, so that the effect on supply of a price change never dies out. The supply model used here, while simple and convenient, is probably just too simple to explain adequately the tremendous expansion in East African tea production since World War II.

Demand equations were estimated for the United Kingdom, India, the United States, Canada, Australia and the rest of the world.

[12] See Murti (1966).

[13] For complete econometric results, see Underwood (1976).

[14] By assuming that "purchasing power parity" holds, we can write all prices in terms of 1967 dollars per kilogram. Quantity variables are in units of metric tons.

(T5)

$$D_t^{UK} = -35{,}100 - 82{,}560PT_t^{US} + 25{,}130PC_t^{US} - 2{,}346PCYI_t^{UK} + 14{,}730POP_t^{UK} + e_t^{UK}$$

(T6)

$$D_t^{I} = -109{,}700 - 303{,}900PT_t^{US} + 25{,}550PC_t^{US} + 0.2499YI_t^{I} + 605.6POP_t^{I} + e_t^{I}$$

(T7)

$$D_t^{US} = -25{,}490 - 109{,}500PT_t^{US} + 13{,}380PC_t^{US} - 10.2Y_t^{US} + 521.8POP_t^{US} + e_t^{US1}$$

(T8)

$$D_t^{C} = 11{,}000 - 29{,}230PT_t^{US} + 7{,}758PC_t^{US} - 146.1Y_t^{C} + 883.9POP_t^{C} + e_t^{C1}$$

(T9)

$$D_t^{A} = -1{,}720 - 24{,}250PT_t^{US} + 6{,}271PC_t^{US} - 106.2Y_t^{A} + 4{,}119POP_t^{A} + e_t^{A}$$

(T10)

$$D_t^{RW} = -365{,}800 - 20{,}830PT_t^{US} + 10{,}440t + e_t^{RW1}$$

Besides the price of tea, the most important determinants of tea demand are the price of its main substitute, coffee (PC), population (POP) and a measure of income, either real income (Y), an index of real income (YI) or an index of per capita real income (PCYI).

A "partial adjustment" demand-for-stocks (ST) equation was also estimated:

(T11)

$$ST_t = 74{,}460 - 9{,}108PT_t^{US} + 0.4221ST_{t-1} + 0.01499D_{t-1} + e_t^{S1}$$

The demand for stocks increases as total world demand (D) increases. The obvious identities close the model.

It is interesting to note that LDC producer groups already exist for both commodities. In 1967 CIPEC (the French acronym for the Intergovernmental Council of Copper Exporting Countries) was formed by Zambia, Zaire, Peru and Chile. Its original purpose was to "halt the drift in copper prices to levels that would not be conducive to the orderly development of the world's copper market and industry."[15] However, CIPEC did not act as a cartel during the period from which the data used in estimating the copper model were drawn (1946–1968).

[15]See Hoban and Taran (1974), p. 10.

There have been International Tea Agreements off and on since 1933. An agreement in effect from 1933 to 1938 (signed by India, Ceylon, Indonesia, Malaya and the British East African territories) limited the expansion of the acreage and restricted exports. It "worked relatively well in maintaining prices."[16] The sporadic agreements since 1938 have not been effective.[17]

III. Results

A. *A Copper Cartel*

The copper market model was estimated using data from the years 1946 through 1968. The cartel is assumed to begin its operation in 1969. The expected gain is calculated in two steps. First the present discounted value of expected export earnings (in 1967 dollars) of the cartel countries is calculated assuming that no cartel exists. Then the present discounted value of optimal export earnings is calculated. The difference is the expected gain due to the cartel.[18] The cartel is assumed to operate for up to ten years. Two different discount rates are used, five and ten per cent.

The results for a ten-year cartel are presented in Table 1. The expected gain in each case is about 2.5 per cent of the no-cartel expected

TABLE 1

Expected Return to a Ten Year Copper Cartel
(In Millions of 1967 Dollars)

	No Autocorrelation	Autocorrelation
1. Discount Rate: 10 per cent		
Optimal Return	33,072	33,148
No-Cartel Return	32,274	32,348
Gain due to Cartel	798 (2.5%)	800 (2.5%)
(Expected Export Tax-Fifth Yr.)	($280 per metric ton)	($216 per metric ton)
2. Discount Rate: 5 per cent		
Optimal Return	43,921	44,009
No-Cartel Return	42,845	42,930
Gain due to Cartel	1,076 (2.5%)	1,079 (2.5%)
(Expected Export Tax-Fifth Yr.)	($201 per metric ton)	($216 per metric ton)

[16] See IBRD (1972), p. 13.
[17] See IBRD (1972), pp. 13 15.
[18] It is assumed that there are no costs to forming and maintaining the cartel.

TABLE 2

EXPECTED RETURN TO COPPER CARTELS OPERATING FROM ONE TO TEN YEARS[a]

Number of Years of Cartel Operation	Expected Gain Due to the Cartel (Millions of 1967 Dollars)	(Percent of No-cartel Expected Earnings)
1	1	(.04%)
2	204	(3.6%)
3	417	(4.9%)
4	580	(5.2%)
5	687	(4.9%)
6	747	(5.3%)
7	776	(3.8%)
8	788	(3.2%)
9	794	(2.8%)
10	800	(2.5%)

[a]These results are from calculations using the method that takes into account the estimated coefficients of autocorrelation and using a discount rate of ten per cent.

return. The results are quite similar whether or not the assumed autocorrelation is ignored. This is simply because the differences between the predicted and observed values in 1968, the year in which the cartel gains are calculated, are quite small. Therefore the original observed e_0 and the expected values of later e_{t-1}'s, which decline in absolute value at geometric rates,[19] have only a small effect on the final results.

The argument is sometimes made that, because the short-run price elasticity of demand for a product like copper is much lower than the long-run elasticity, a cartel operating for a very short period could increase export earnings dramatically. Therefore, the expected gains to copper cartels planning to operate from one to ten years were calculated. The results are presented in Table 2. Relative to no-cartel earnings, the expected gain is largest for a six-year cartel, 5.3 per cent.

In each case, the optimal expected return is calculated ignoring the post-cartel future. For example, if the cartel countries chose to run a six-year cartel beginning in 1969 and ending in 1974, their expected gain in export earnings over ten years would be less than the $800 million return to a ten-year cartel. In order to partially take into account the post-cartel future, the expected return over the first ten years of a twenty-year cartel was calculated. The expected gain was found to be $424 million, or 1.3 per cent of the ten-year no-cartel expected return.

[19]$E(e_1) = \Lambda e_0$; $E(e_2) = \Lambda^2 e_0$; etc.

B. *A Tea Cartel*

The tea cartel considered would consist of India, Sri Lanka and the main East African tea producing countries (Kenya, Uganda, Malawi, Mozambique and Tanzania). This cartel is assumed to operate for up to ten years beginning in the first post-sample year, 1972.

The results for a ten-year cartel are presented in Table 3. The calculated expected gain averages about 29 per cent of the no-cartel expected return. Again, and for the same reason, ignoring the estimated coefficients of autocorrelation changes the results only slightly.

Table 4 gives the results for cartels operating from one to ten years. This time, the expected gain (relative to the no-cartel expected return) is highest for a one-year cartel. In dollar terms the gain to a one-year cartel is over one-half of the gain to a ten-year cartel.

Again these calculations are made without taking into account the post-cartel future. To partially take this future into account the expected gain over the first ten years of a twenty-year cartel was calculated and found to be $824 million, 24 per cent of the ten-year no-cartel expected return.

Why is the percentage expected gain so much higher for a tea cartel than for a copper cartel? Stern and Tims (1975) speculated that a copper cartel would have a fair chance of realizing a sizeable gain but gave a tea cartel little or no chance of success. Essentially, the net demand curve fac-

TABLE 3

EXPECTED RETURN TO AN INDIA-SRI LANKA-EAST AFRICA TEA CARTEL
(IN MILLIONS OF 1967 DOLLARS)

	10-year Cartel-No Autocorrelation	10-year Cartel-Autocorrelation
1. Discount Rate: 10 per cent		
Optimal Return	4.338	4.261
No-cartel Return	3.375	3,288
Gain due to Cartel	963 (28.5%)	973 (29.6%)
(Expected Export Tax-Fifth Yr.)	($1.05 per kg.)	($1.10 per kg.)
2. Discount Rate: 5 per cent		
Optimal Return	5.445	5.358
No-cartel Return	4.259	4.158
Gain due to Cartel	1.186 (27.8%)	1,200 (28.9%)
(Expected Export Tax-Fifth Yr.)	($0.93 per kg.)	($0.98 per kg.)

TABLE 4

EXPECTED RETURN TO INDIA-SRI LANKA-EAST AFRICA TEA CARTELS OPERATING FROM ONE TO TEN YEARS[a]

Number of Years of Cartel Operation	Expected Gain Due to the Cartel (Millions of 1967 Dollars)	(Percent of No-cartel Expected Earnings)
1	488	(97.7%)
2	680	(74.6%)
3	770	(58.5%)
4	820	(48.4%)
5	852	(41.8%)
6	877	(37.2%)
7	899	(33.9%)
8	919	(31.5%)
9	940	(29.8%)
10	963	(28.5%)

[a]These results were calculated using the method that ignores autocorrelation and using a discount rate of ten per cent.

ing the copper cartel is not very inelastic at current prices. Estimated long-run primary supply elasticity is quite high in the United States and Canada, the two primary producer countries not in the cartel. The increase in production of copper from scrap with the introduction of a cartel also contributes to the small expected gain.

IV. CONCLUSIONS

As was stated in the introduction, a large expected return can be thought of as a necessary, but not sufficient, condition for the successful formation and maintenance of a cartel. Is this condition fulfilled for the tea cartel considered above? A 29 per cent increase in export earnings from tea is certainly nothing like the 500 per cent increases in total export earnings experienced by many of the OPEC countries. It amounts to about one billion 1967 dollars over ten years to be split among seven countries. Assuming that the gains are split such that each country has an equal increase in expected tea export earnings, the gain in total export earnings, as a percentage of recent average total export earnings, would range from about 1 per cent for Tanzania to 13 per cent for Sri Lanka. This tea cartel would seem to have, at best, a borderline chance of success.

Based on the results presented here, the chances for the successful formation of a copper cartel by CIPEC or any other producer group not including the United States and/or Canada appear remote. This is not to say that no type of international copper agreement could be beneficial to LDC copper producers. Perhaps an agreement that would reduce the cyclical fluctuations in copper export earnings would be of benefit to countries like Zaire and Zambia which suffered due to the low copper prices of the recent world wide recession.

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