DIVISION OF THE HUMANITIES AND SOCIAL SCIENCES

CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA 91125

POLITICAL POWER IN THE INTERNATIONAL COFFEE
ORGANIZATION: A RESEARCH NOTE*

Da-Hsiang Donald Lien
California Institute of Technology

Robert H. Bates
Duke University

SOCIAL SCIENCE WORKING PAPER 587

November   1985

INTRODUCTION

In recent decades, international commodity agreements have been proposed as a way of promoting "development." Behrman, McNicol and others have analyzed them from a purely economic point of view. Fisher, Krasner, and others have adopted a more political perspective. In this article, we seek to advance the political analysis of such agreements. We do so by studying the allocation of export entitlements in the International Coffee Organization (ICO).

In the ICO, as in other international organizations, political processes replace markets in the allocation of source resources. In the case of the ICO, allocational decisions are made by majority rule. Given the possibility of strategic behavior in such political environments, game theory should provide a useful set of tools for the analysis of such institutions. A particular interest of this article is the appropriateness of a specific solution concept--the Shapley value--to the analysis of politically contrived allocations under the ICO.[1]

THE INSTITUTION[2]

The International Coffee Organization was formed under the terms of the International Coffee Agreement ratified in 1962. Its members include the major consumer nations (which account for 95 percent of annual world consumption) and the major producer nations (which account for 98 percent of annual world export). The agreement represents an attempt to stabilize the coffee prices. To achieve this goal, the ICO imposes quota restrictions upon its members. Each producer agrees not to export more than his assigned quota. Adherence to the quota is enforced through a system of stamps and certificates. Producers which have filled their quotas can make further sales on the nonquota market; prices on that market, however, currently average less than one-half of those on the quota market.

Formally, decisions concerning the allocation of the quota are taken by vote. Consumer nations receive 1000 votes; so too do producer nations; and a two-thirds majority of each "house" is required to establish a binding allocation. Despite the rules, interviews reveal that while producer and consumer nations do negotiate the overall price and quantity levels, consumer nations refuse to get involved in the subdividing of the overall quota into national quotas. For purposes of analyzing the allocation of quotas, then, we may concentrate solely on the producer nations.

THE ANALYSIS

The data we shall analyze are the two proposals for quota allocations advanced after the reimposition of export restrictions in 1982. One, proposed in June, 1982, failed to secure adoption by the member states; another was proposed in September, 1982, and was ratified.

The above rules define a weighted majority game (see Luce and Raiffa; Riker and Ordeshook). Various approaches are available for predicting allocations within an institution possessing such a structure. A common feature of these different solution concepts is that they represent a measure of the political power of players to influence outcomes, given the rules of the institution. Although we agree with many of the criticisms offered of the Shapley value, we have calculated the Owen Approximation of it and sought to determine whether it allows us to account for the allocation of the coffee quota and the votes of individual nations in 1982. Mathematically, for our problem, the Shapley value for the i-th player (S_i) is defined as:

$$S_i = \sum_{i \varepsilon T} \frac{(t-1)!(N-t)!}{N!}$$

where the summation is taken over all winning coalitions (i.e., a collection of members for which the summation of votes exceed two-thirds of the total votes) T

such that $T - \{i\}$ is not winning. The number of members in T is t and N is the number of players. The Shapley value thus measures the ability of a player to use its share of votes to turn coalitions into electoral majorities. Its measure is the proportion of all possible coalitions that a player can convert into winning coalitions. The ability of the player to be pivotal in that sense defines the player's political power. Consequently, the Shapley value defines as well the share of the payoffs that each player can expect to get, given its ability to exploit its strategic opportunities to make (or to refuse to make) coalitions into winning coalitions. It therefore suggests as well the allocational outcome of the game in terms of the payoffs that should be expected to go to each player. Table 1 exhibits the Owen approximation of Shapley value for each player, along with other important data.

<center>(TABLE 1 ABOUT HERE)</center>

<center>The Votes of Individual Nations</center>

In the case of both proposals, six nations cast negative votes. Colombia, Indonesia, Kenya, Papua New Guinea, Tanzania, and India voted against the proposal of June, 1982, while Indonesia, Costa Rica, Honduras, Peru, Papua New Guinea, and India voted against the proposal of September, 1982.

We are in a position to investigate two possible explanations for the voting behavior of member nations of the ICO. One is that they would evaluate a proposal in terms of what they had been securing in the international coffee market. Another is that they would evaluate a proposal in terms of what they could expect to get from negotiations with other member nations. The first leads to a definition of an explanatory variable, $Z_{\cdot i}$, where $Z_{\cdot i}$ is the difference between the quota assigned in the proposal ($q_{\cdot i}$) and the nation's previous year's (i.e., in our problem, 1980/81) export share (e_i). That is, $Z_{\cdot i} = q_{\cdot i} - e_i$. The second leads to the definition of an alternative explanatory variable, $X_{\cdot i}$. $X_{\cdot i}$ is measured in terms of the difference

between the quota assigned in the proposal and the nation's Shapley value (S_i). That is, $X_{\cdot i} = q_{\cdot i} - S_i$. All variables are measured in percentage terms and $\cdot$ stands for either 1 or 2, that is, (1) the proposal of June 1982 which failed, or (2) the second proposal, made in September, which passed.

To test these explanations of voting behavior, we adopted probit procedures. Specifically, let Y_{ji} be a dichotomous variable such that $Y_{ji} = 1$ if producer i voted for j proposal; $Y_{ji} = 0$ otherwise. The models can be stated as:

$$Prob\,(Y_{ji} = 1) = \phi\,(\alpha + \beta X_{ji} + \gamma Z_{ji})$$

where $Prob\,(Y_{ji} = 1)$ denotes the probability that $Y_{ji} = 1$; $\phi(u)$ denotes the cumulative density of a standard normal variable evaluated at u; α, β, γ are scalars which we will estimate. In other words, the models predict that producer i voted for j proposal if $\alpha + \beta X_{ji} + \gamma Z_{ji} \geqq 0$ and otherwise voted against j.

In these and other areas of this investigation, we have found it useful and necessary to treat the Colombian milds--Kenya, Tanzania, and Colombia--as a bloc. More specifically, the data suggest and interviews confirm that the three nations act as a bloc led by Colombia, wherein Colombia evaluates proposals in terms of their effect on *its own* quota, whereas Kenya and Tanzania evaluate the proposals in terms of their impact on the share of Colombian milds in the allocation as a whole.[3] In the models that follow, we therefore replace X_{ji} and Z_{ji} by $\bar{X}_{ji}$ and $\bar{Z}_{ji}$, where $X_{ji} = \bar{X}_{ji}$ if $i \notin \{\text{Kenya, Tanzania}\}$; $\bar{X}_{ji} = $ the summation of X_{ji} over $i\varepsilon\{\text{Colombia, Kenya, Tanzania}\}$ if i is Kenya or Tanzania. A similar definition applies to $\bar{Z}_{ji}$.

With these modifications, the results of these estimations are:[4]

The Proposal That Failed

(1)
$$Prob\,(Y_{1i}=1)=\phi\,(1.2348+3.5834\,\,\bar{X}_{1i})$$

$$(0.5903)\,\,(3.0535)$$

$$log-likelihood = -4.4115$$

(2)
$$Prob\,(Y_{1i}=1)=\phi\,(1.3402+1.9128\,\,\bar{Z}_{1i})$$

$$(1.0134)\,\,(0.5671)$$

$$log-likelihood = -3.4103$$

(3)
$$Prob\,(Y_{1i}=1)=\phi\,(1.3125+0.4353\,\,\bar{X}_{1i}+1.6752\,\,\bar{Z}_{1i})$$

$$(0.5710)\,\,(1.3332)\,\,\,\,\,\,(2.0525)$$

$$log-likelihood = -3.3738$$

The Successful Proposal

(4)
$$Prob\,(Y_{2i}=1)=\phi\,(0.6\,\,\,\,\,\,+0.1837\,\,\bar{X}_{2i})$$

$$(0.3207)\,\,(0.2212)$$

$$log-likelihood = -11.8122$$

(5)
$$Prob\,(Y_{2i}=1)=\phi\,(1.0951+6.3769\,\,\bar{Z}_{2i})$$

$$(0.5863)\,\,(2.8622)$$

$$log-likelihood = -2.2835$$

(6)
$$Prob\,(Y_{2i}=1)=\phi\,(1.2671-0.1591\,\,\bar{X}_{2i}+6.5049\,\,\bar{Z}_{2i})$$

$$(0.7933)\,\,(0.5981)\,\,\,\,\,\,(3.0281)$$

$$log-likelihood = -1.90355$$

Except in equation (6), all the coefficients associated with $\bar{X}_{ji}$ and $\bar{Z}_{ji}$ have the expected positive sign. That is, if a proposal assigned an individual nation a quota larger than its Shapley value or its previous year's export share, the nation was more likely to vote for that proposal.

Upon calculating the t-statistics (the numbers within the parentheses denote standard deviations), we find that all the constant terms are significant at 90 percent confidence level. None of the coefficients associated with $\bar{X}_{ji}$ is significant at 80 percent confidence level. The coefficients associated with $\bar{Z}_{ji}$ differ across the equations: they are significant at the 95 percent confidence level for equations (5) and (6); at the 90 percent confidence level in equation (2); and insignificant for equation (3).

These results may be interpreted as indicating:

1.   There is a general tendency to vote for proposals. Interviews suggest that the origins of this tendency lie in a fear that without an agreement on quotas, the regulation of the international market will break down. Each nation would then be faced with unrestricted competition.

2.   The Shapley value is not a significant determinant of the voting behavior of individual nations.

3.   Consideration of the impact of a quota proposal upon existing market shares is a significant determinant of an individual nation's voting behavior (although the results are not as clear-cut as one would like in the case of votes on the proposal that failed).

The Allocation of the Quota

Given the failure of "Shapley entitlements" to determine voting decisions by individual nations, it is paradoxical to discover that the final allocation of the quota tended to conform to the Shapley value.

The rules of the organization allocate indicative quotas--that is, claims as to what a nation's quota might justifiably be. Under the rules prevailing in 1982 (specifically, Article 30), nations could base claims for quotas on their average exports for the period 1968/69 to 1971/72 or for the period 1976/77 to 1979/80. The rules also allocate votes. Under Article 13, votes were apportioned on the basis of the average volume of exports to importing members over the previous four years (i.e., 1976/77 to 1979/80).

These rules can be modeled and estimated as a system of equations:

(7)
$$W_i = 0.3783 + 0.9242 \, P_{1i} \qquad \text{By Article 13}$$
$$ (0.0161) \; (0.0021)$$

(8)
$$S_i = 0.8227 \, W_i + 0.0156 \, W_i^2 \qquad \text{By assumption of rational behavior}$$
$$ (0.0031) \qquad (0.0018)$$

(9)
$$q_{1i} = 0.1354 + 0.9410 \, P_{2i} + 0.0322 \, S_i \qquad \text{By Article 30 and prediction}$$
$$\phantom{q_{1i} =} (0.1232) \; (0.0684) \qquad (0.0758)$$

(10)
$$q_{2i} = -0.2279 + 0.8281 \, P_{2i} + 0.2175 \, S_i \qquad \text{By Article 30 and prediction}$$
$$\phantom{q_{2i} =} (0.1214) \; (0.0674) \qquad (0.0746)$$

where W_i is the proportion of votes held by voter i; P_{1i} is producer i's average export share from 1976/77 to 1979/80; P_{2i} is the maximum of producer i's average export share for the period 1968/69 to 1971/72 or for the period from 1976/77 to 1979/80. All the variables are measured in percentages. The system was estimated by two-stage least squares, using the constant term, P_1. and P_2. as instrumental variables, to eliminate the relationship between S_i and q_{1i}, q_{2i} that was indirectly produced through their association with export performance.

As shown in equations (9) and (10), the coefficient of the Shapley value is insignificant in the case of the quota that failed; but it is significant in the case of the quota that passed. In other words, the proposal that accommodated the strategic power as measured by the Shapley value succeeded while the proposal that did not failed.

CONCLUSION

We thus encounter a paradox. Consideration of the Shapley value does not appear to influence a nation's votes on a proposed quota. But proposed quotas pass when they conform to the Shapley value and fail when they do not.

The resolution of this paradox may lie in the following: In the ICO, a proposal is first negotiated, then proposed, and then voted upon. It is during the period of negotiations that each nation attempts fully to exploit its political power in order to improve upon its export position. It is thus in the process of negotiations, rather than at the time of voting, that the strategic power as measured by the Shapley value may have its effect upon the allocational process in the commodity agreement.

NOTES

1. As discussed in Riker and Ordeshook and elsewhere, the Shapley value makes several assumptions that are not intuitively appealing. Unlike many other solution concepts, however, it does possess an algorithm which allows it to be calculated even when the number of players is large. We have therefore employed it to explore the impact of the political rules of the commodity agreement upon the voting behavior of its members and the allocation of export entitlements.

2. This discussion is taken from Bates and Lien. See also Krasner and Fisher.

3. Bates served as a technical advisor to the 1985 meetings of the ICO and made extensive observations during the negotiations.

4. We employed maximum likelihood estimation and the model selection criteria proposed by Akaike. The Akaike criteria were imposed here to select the explanatory variables (i.e. $\overline{X}_{ji}$ and $\overline{Z}_{ji}$ over X_{ji} and Z_{ji}). The estimation results with X_{ji} and Z_{ji} being explanatory variables are as follows:

(1')
$$Prob\,(Y_{1i}=1)=\phi\,(0.6074+1.7778\ X_{1i})$$
$$(0.3571)\ (1.4983)$$
$$log-likelihood = -8.1767$$

(2')
$$Prob\,(Y_{1i}=1)=\phi\,(0.6806+1.3552\ Z_{1i})$$
$$(0.3710)\ (0.6964)$$
$$log-likelihood = -7.4169$$

(3')
$$Prob\,(Y_{1i}=1)=\phi\,(0.6586+0.4320\ X_{1i}+1.1218\ Z_{1i})$$
$$(0.3793)\ (1.3521)\qquad (0.9421)$$
$$log-likelihood = -7.3482$$

(4')
$$Prob\,(Y_{2i}=1)=\phi\,(0.6513+0.4769\ X_{2i})$$
$$(0.3370)\ (0.3471)$$
$$log-likelihood = -10.8518$$

(5')
$$Prob\,(Y_{2i}=1)=\phi\,(4.6040+16.0237\ Z_{2i})$$
$$(4.8099)\ (15.4748)$$
$$log-likelihood = -2.6297$$

(6')
$$Prob\,(Y_{2i}=1)=\phi\,(-0.4679\ X_{2i}+3.9399\,Z_{2i})$$
$$(0.5630)\qquad (1.6029)$$
$$log-likelihood = -7.0644$$

Comparing the log-likelihood for equations (1')-(6') to that of equations (1)-(6) respectively, we find that $\overline{X}_{ji}$ and $\overline{Z}_{ji}$ are better explanatory variables than X_{ji} and Z_{ji}.

REFERENCES

Akaike, H. "Information Theory and an Extension of the Likelihood Ratio Principle." Proceedings of the Second International Symposium of Information Theory, ed. by B. N. Petrov and F. Csáki. Budapest: Akademial Kiads, 1973, 257-281.

Behrman, Jere R. Development, the International Economic Order, and Commodity Agreements. Reading, MA: Addison-Wesley Publishing Co., 1978.

Bates, Robert H. and Da-Hsiang Donald Lien. "On the Operations of the International Coffee Agreement." International Organization 39(1985): 553-559.

Fisher, Bart S. The International Coffee Agreement. New York, NY: Praeger Press, 1972.

Krasner, Stephen D. "Manipulating International Commodity Markets." Public Policy 21(1973): 493-513.

Luce, R. D. and Raiffa, Howard. Games and Decisions. New York, NY: John Wiley & Sons, Inc., 1957.

McNicol, David L. Commodity Agreements and the New International Economic Order. Social Science Working Paper No. 144, Division of Humanities and Social Sciences, California Institute of Technology, Pasadena, CA (revised), 1977.

Owen, Guillermo. Game Theory. New York, NY: Academic Press, 1982.

Riker, William H. and Ordeshook, Peter C. An Introduction to Positive Political Theory. Englewood Cliffs, NY: Prentice-Hall Publishing Co., 1973.

TABLE 1. The data

Nation	Shapley Value (%)	Successful Proposal (%)	Failed Proposal (%)	80/81 Adjusted Export Share[c] (%)
Brazil	25.35	30.83	30.00	27.80
Colombia	18.72	16.28	14.03[b]	16.30
OAMCAF	11.01	11.96	12.00	11.87
Indonesia	7.48	4.55[a]	4.75[b]	6.84
El Salvador	4.81	4.48	5.24	4.30
Mexico	3.95	3.65	3.93	3.45
Guatemala	3.81	3.47	4.16	3.31
Uganda	3.53	4.44	4.64	3.49
Costa Rica	2.39	2.16[a]	2.24	2.76
Kenya	2.29	2.48	2.46[b]	2.13
Ecuador	2.18	2.17	2.28	1.83
Ethiopia	1.95	2.62	2.42	2.52
Zaire	1.95	2.12	2.20	1.80
Honduras	1.88	1.49[a]	1.62	1.80
Peru	1.68	1.31[a]	1.55	1.61
Nicaragua	1.59	1.28	1.53	1.49
Papua New Guinea	1.48	1.16[a]	1.47[b]	1.52
Tanzania	1.48	1.36	1.51[b]	1.69
India	1.35	1.24[a]	0.99[b]	2.62
Dominican Rep.	1.10	0.95	1.00	0.87

a = The nations voting against the successful proposal.
b = The nations voting against the failed proposal.
c = The adjusted export share is defined as the export share divided by 98.84 (i.e., the aggregate export share for ICO members).