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A NOTE ON THE OPERATIONS OF THE INTERNATIONAL COFFEE AGREEMENT

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Abstract

This research note develops a model of the institutional features of the international coffee agreement and analyzes the allocation of export quotas under the terms of the agreement in 1982. It suggests that the agreement can be viewed as a weighted majority voting game. It employs the assumption of rationality to predict how allocations should be made given the rules of the agreement and tests the model by determining whether the allocations which passed (failed) fell within (outside) of the solution of the game.

A Note on the Operations of the International Coffee Agreement*

Robert H. Bates and Da-Hsiang Donald Lien

In this research note, we analyze the allocation of quotas to export coffee in 1982 under the terms of the international coffee agreement.

Next to oil, coffee is the most valuable commodity traded in world markets; it is produced in the developing world and consumed within the developed nations. Moreover, the international coffee agreement stands as the major successful international commodity agreement. A study of the way in which entitlements to export are allocated under the terms of the agreement therefore offers insights into significant features of the international political economy.

The analysis is also important for analytic reasons. In recent years, scholars of international relations have exported the rational choice perspective from the field of strategic studies and applied it in other domains. In particular, important attempts have been made to apply rational choice analysis to the analysis of international agreements and the behavior of international organizations.[1] Our research note seeks to advance this trend. It does so by modeling an international political institution -- the international coffee agreement; and, assuming rational behavior, by analyzing the way in which that institution affects the international allocation of economic resources -- in this instance, export entitlements.

Background

The international coffee agreement was ratified in 1962. Its membership includes the major consuming nations of Europe and North America, who account for 95 percent of annual consumption. Among producing nations, its membership includes every major exporter; only a handful of countries, each producing less than 100,000 bags per annum, remain outside the agreement.

The agreement represents an attempt by producing and consuming nations to stabilize the price of coffee. The primary mechanism for price stabilization is the restriction of supplies to a level sufficient to maintain coffee prices within an agreed upon range (at the present time (1984) $1.20 to $1.40 a pound). The restrictions take the form of the imposition of quotas. To support the agreed upon price level, each producer agrees not to ship more than its assigned quota. Adherence to the quota is enforced through a system of stamps and certificates; the customs authorities of importing nations remit copies from each shipment to the headquarters of the organization which in the case of an overshipment can then call for a reduction of a country's quota. Producers which have fulfilled their quota can make further sales on the non-quota market; however, prices on that market currently average less than one-half of these on the quota market.[2]

Frosts, insurrections and other "acts of God" have from time to time forced prices above the defense range, thereby leading to the suspension of quantity restrictions. The most recent suspension of the terms of the agreement occurred following the Brazilian frost of 1975.

Expanded production by other countries subsequently forced prices back down into the defense range, triggering a return to export restrictions. The question then arose: how was the burden of the restrictions to be allocated among producer nations? This note analyzes the apportioning of that burden in terms of the setting of quota restrictions upon exporters. It does so by analyzing the fate of two proposals for quota allocations which were advanced after the reimposition of export restrictions: one which was proposed in June 1982 and which failed to secure adoption by the member states and another which was proposed in September 1982 and which was ratified.

The Institution

Formally, decisions having to do with 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. Each nation receives a "base" vote plus additional votes based upon its past performance as a shipper or importer of coffee. While not all decisions in fact come to a vote, interviews with officers of the organization and delegates to its meetings suggest that anticipation of whether or not a measure would pass were it to be called to a vote helps to define whether it is a viable, as opposed to "defeatable," proposal. The threat to use the rules to vote down proposals plays a significant role in negotiations.

While the rules of the organization state that production quotas must be agreed to by a two-thirds majority of the votes of both the consumers and producer members, interviews reveal that while producer

and consumer nations in fact do negotiate the overall price and quantity levels, the consumer nations refuse to get involved in the process of subdividing the overall quota into national quotas. When queried, American delegates noted that such involvement would cost a consumer nation more than it would gain; almost all of the producers are "our friends," they indicated, and rewarding one with an increased national quota would only antagonize all the others whose quotas were diminished as a result.

The rules of the organization allocate indicative quotas -- i.e. claims as to what a nation's quota might justifiably be. When calculating the quota entitlement of members upon the re-imposition of the agreement, the rules (specifically, Article 30) were written to allow producing nations to base their claims for a quota on their average exports for the period 1968/69 to 1971/72 or for the period 1976/77 to 1979/80. Interviews made clear the reasons for this provision: In 1975, Brazil had been hit by a major frost; Columbia had expanded exports to take advantage of Brazil's misfortune; and to secure the adherence of the two "giants," each had to be allowed to pick that basis for its quota which was most favorable.

The rules also allocate votes. The votes are allocated on a weighted basis. Under Article 13 of the agreement at the time of the quota proposals of June and September 1982 -- the quotas which we wish to analyze -- 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].[3]

These rules define an institution amenable to analysis by rational choice theory. They define a weighted majority voting game. A variety of approaches are available for predicting allocations within the context of an institution possessing such a structure but most are extremely difficult to apply to "real world cases," e.g. where the number of actors is large. There is one solution concept for which an algorithm exists which makes such applications possible: the Shapley value. In exploring the applicability of rational choice analysis to the analysis of international political institutions, we employ the Shapley value.

The Shapley value can be thought of as a measure of the power of players to influence outcomes, given the rules of an institution. In an institution which allows weighted votes, the Shapley value can be thought of as a measure of 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 which a player can convert into winning (i.e. majority) coalitions. The ability of the player to be pivotal in that sense defines the player's power. The Shapley value therefore defines as well the share of the payoffs which each player can expect to get, given its ability to exploit its strategic opportunities to make (or to refuse to make) coalitions into winning coalities. It therefore suggests as well the allocational outcome of the game, in terms of the payoffs which should be expected to go to each player. While we agree with many of the criticisms offered 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 in 1982.[4]

The Analysis

Our discussion implies the following model of the institution:

(1) $w_i = f(p_{1i})$ By Article 13.

(2) $S_i = g(w_i)$ By assumption of rational behavior.

(3) $q \cdot i = h(S_i, p_{2i})$ By Article 30 and prediction.

where

w_i = The proportion of votes held by producer i.

S_i = The Shapley value of producer i.

q_{1i} = The quota assigned to producer i, under the June 1982 proposal.

q_{2i} = The quota assigned to producer i, under the September 1982 proposal.

p_{1i} = Country i's average export share to importing members of the ICO, 1976/77 to 1979/80.

p'_{1i} = Country i's average export share to importing members of the ICO, 1968/69 to 1971/72.

p_{2i} = The maximum of either country i's average export share to importing members of the ICO for periods 1968/69 to 1971/72 (p'_{1i}) or for the period 1976/77 to 1979/80 (p_{1i}).

The three equations represent a model of the way in which the institution and its rules determine the allocation of the quota. The most direct test of this model of the operations of the coffee agreement is offered by coefficients in equation 3, which, along with the other equations, can be estimated through two-stage least squares

using the constant term, p_1 and p_2 as instrumental variables.

If rational behavior determines the impact of the rules of the international coffee agreement upon allocations, then we can make two predictions. We would not expect the coefficient of the Shapley value to be significant in the case of the quota that failed (q_1); we would expect it to be significant in the case of the quota that passed (q_2). Given that the institution defines a weighted majority voting game, in other words, we would expect that a quota allocation which "passed" would have to conform to the (Shapley) solution of the game. As can be seen in the following results, our expectations are fulfilled:

$$q_1 = \underset{(1.0986)}{0.1354} + \underset{(13.7564)}{0.9410p_2} + \underset{(0.4246)}{0.0322S}$$

$$q_2 = \underset{(-1.8765)}{-0.2279} + \underset{(12.2902)}{0.8281p_2} + \underset{(2.9156)}{0.2175S}$$

The figures in parentheses are t-statistics with seventeen degrees of freedom.

An additional result is of interest: we find that the Shapley value explains the allocation of the quota better than the measure of raw votes, or, in particular, the proportion of votes. The Shapley value bears the following relationship to the proportion of votes:

$$S \underset{(26.6932)}{0.8227w} + \underset{(8.7515)}{0.0156w^2}$$

In this instance, there are eighteen degrees of freedom. We have constrained the intercept to be zero because it makes little sense for a country possessing no votes to be able to convert coalitions into majority winners which might otherwise remain voting minorities. The sign and significance of the second coefficient suggests, as one would expect, that big powers are disproportionately advantaged by their ability to "pivot" — that is, to convert coalitions into majorities. But what is most interesting is what happens when this approximation to the Shapley value is substituted into the equation "predicting" q_2, i.e. the successful quota.

$$q_2 = \underset{(0.2019)}{0.0388} + \underset{(1.4702)}{0.0934w} + \underset{(2.2815)}{0.0086w^2} + \underset{(14.7572)}{0.8050p_2}$$

$$R^2 = 0.9981$$

Here there are sixteen degrees of freedom. The coefficient of w^2 still remains significant. This result suggests it is not just votes which determine quotas; rather, it is also the strategic advantages confined by requirement that votes be majorities — advantages which accrue disproportionately to the bigger powers (such as Brazil) and give them larger quotas than one would expect, given the distribution of votes.[5]

Conclusion

By way of conclusion, it is interesting to summarize the economic impact of the political rules defined by the international coffee agreement by calculating on the basis of the values of the parameters estimated above the economic value of an additional vote. Assuming

that coffee sells at $1.40 a pound; that a bag contains 132 lbs.; and that the world's exportable production is constrained to 58 million bags, then, according to the above equation, for a very small producer (say Kenya with 23 votes), an additional vote would be worth about $168.5 million per annum. For a "large" producer (say Brazil with 190 votes), an additional vote would be worth $566.1 million per annum. Given the third world's need for foreign exchange, the magnitude of these values suggest the economic significance of the political features of the coffee agreement.

Notes

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1. The most notable recent application in strategic studies is Bruce Bueno de Mesquita, The War Trap (New Haven and London: Yale University Press, 1981). For extensions to areas of agreement and cooperation, see Robert Axelrod, The Evolution of Cooperation (New York: Basic Books, 1984). Coming closest to the approach being explored in this note is Robert Keohane, After Hegemony (Princeton: Princeton University Press, 1984).

2. For background, see Bart S. Fisher, The International Coffee Agreement (New York: Praeger, 1972); Thomas Geer, An Oligopoly: The World Coffee Economy and Stabilization Schemes (New York: Dunellen, 1971); Stephen D. Krasner, "Manipulating International Commodity Markets," Public Policy, 21, no. 4 (1973):493-513; J. W. F. Rowe, The World's Coffee with Special Reference to Control Schemes (Stanford: Food Research Institute, Stanford University, 1943); and Robert H. Bates and Da-Hsiang Donald Lien, "Coffee: An Essay on the Origins and Operations of Political Intervention in International Markets," unpublished.

3. For a variety of practical reasons we have had to assume that there is a one-year lag in revising the votes. Although this might not be realistic, because of the stability of market shares in the short run, this regression result should still apply even if we assume no lag in the allocation of votes.

4. A useful introduction to the Shapley value, its problems and other solution concepts is contained in William H. Riker and Peter C. Ordeshook, An Introduction to Positive Political Theory (Englewood Cliffs: Prentice Hall, Inc., 1973). For the approximation to the Shapley value employed in this paper, see Guillermo Owen, Game Theory (New York: Academic Press, 1982). For our problem, the Shapley value for i-th player is defined as:

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

where the summation is taken over all winning coalitions (i.e. a collection of members for which the summation of votes exceeds two-thirds of the total votes) T such that T-{i} is not winning, t is then the number of elements in T, and N is the number of players. A major problem with the Shapley value is that in

calculating it all coalitions are treated as equally likely. Under many circumstances, this is likely to be untrue.

5. We can also estimate the system by GLS, which yields the following results:

$$(1)\quad w = \underset{(2.3540)}{0.3783} + \underset{(44.1826)}{0.9242p_1}$$

$$(2)\quad s = \underset{(29.8017)}{0.8399w} + \underset{(9.0766)}{0.0146w^2}$$

$$(3)\quad q_1 = \underset{(1.6557)}{0.1889} + \underset{(18.1544)}{1.0234p_2} - \underset{(0.9837)}{0.0610S}$$

$$(4)\quad q_2 = \underset{(1.6913)}{-0.1986} + \underset{(15.0502)}{0.8732p_2} + \underset{(2.6081)}{0.1665S}$$

Using two-stage least square estimation, the first equation is

$w = \underset{(2.3540)}{0.3783} + \underset{(44.1826)}{0.9242p_1}$, the same as obtained by GLS.

The two methods yield almost the same estimation and maintain the same qualitative results. In general, when error terms across equations are correlated, GLS will be biased. But for small sample cases, there are some situations in which GLS will dominate two stage least squares. See Robert S. Mariano, "Analytical Small-Sample Distribution Theory in Econometrics: The Simultaneous-Equations Case," International Economic Review 23 (October 1982): 503-33. We therefore provide both estimates for comparison.