

POWER RELATIONSHIPS IN THE INTERNATIONAL MONETARY FUND: THE CONSEQUENCES OF QUOTA CHANGES

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THERE is a widespread agreement that the International Monetary Fund (IMF) has played a central role in fostering a dynamic and open international economy in the postwar period. As the world economy evolved, the consensus has also emerged, however, that substantial changes were required in the Fund's rules so as to make them better reflect the changing power relationships among its members. In an attempt to make these changes, the "Proposed Second Amendment to the Articles of Agreement of the International Monetary Fund" (IMF, 1976) was offered to the IMF's members for ratification along with a change in the distribution of the members' quotas. The new rules became effective as of April 1, 1978, when the amendment was ratified by the required 60% of members with 80% of the total vote.

It is the purpose of this paper to demonstrate, using some simple game theoretical tools, that in many cases the framers of these amendments and quota changes have achieved a result that may be exactly the opposite of their intentions. More specifically, we will show that

1) Under the proposed changes 38 countries in the IMF have their percentage of the total vote decreased and yet their voting power within the organization increased when power is measured by the Banzhaf power index.

2) With the new vote weight distribution and voting rules, four major countries—Belgium, Holland, West Germany and Japan have their percentage of the total vote increased and yet have their percentage of the total power decreased.

Paradoxical results of this variety were discussed theoretically by Fischer and Schotter (1978) and labeled the "Paradox of Redistribution."¹

3) Under the previous distribution of votes and voting rules, smaller countries had voting powers that were out of proportion to their voting weights, and the newly introduced changes would generally aggravate this disproportion.

4) The power of the United States within the Fund increases substantially on issues where most countries vote through their Executive Directors (as groups), as opposed to issues where they vote through their Governors (individually).

5) Under both the previous and current voting system, significant diminishing returns to voting weights exist and the tendency is more pronounced under the new system. In most voting situations power is a concave function of voting weight with large linear segments.

6) Although these results are in many instances not quantitatively substantial, qualitatively they indicate a noticeable discrepancy between what one would think the consequences of the voting changes would be and what they actually are.

In this paper we will proceed as follows: Section I will present some background material about the voting procedures at the IMF. Section II will discuss the index that we are using to measure power. Section III will present the results of our calculations and discuss their significance. Finally, section IV will offer some conclusions and consider the relevance of our findings.

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¹ In that paper, the authors proved that such a paradox is inevitable for any voting body larger than some minimal size in the sense that for any given voting distribution, w , there always exists another distribution, w' , for which, a move from distribution w to w' would result in a paradox of redistribution. The authors have shown that the paradox is by no means a rare event (it has a probability of occurrence as high as 30%).

I. Voting in the IMF

The organization of the IMF is simple. All powers of the Fund are vested in its Board of Governors, which is composed of all the Fund's member countries. Each country has 250 votes plus one additional vote for each part of its quota that is equivalent to one hundred thousand Special Drawing Rights (SDRs). The Board of Governors may, however, delegate certain decisions to be made to the Fund's Board of Executive Directors, which is composed of one representative from each of the five members of the Fund having the largest quotas plus 15 other representatives each of whom represents a certain subset or coalition of countries. There are then 20 Executive Directors, each one having the number of votes equal to the sum of the votes contained in the subset of countries it represents. Thus, voting by the Directors is, in fact, a two stage process. First each coalition meets and agrees (using a simple majority rule) on how its representative (Executive Director) will cast his vote in the body of Executive Directors. Then the Executive Directors themselves meet and, using a decision rule that is not necessarily a simple majority rule, cast their votes.

Essentially, decisions binding on all IMF members can be taken by either the required majority of votes cast by the voting body of Governors or the required majority of votes cast by the voting body of Executive Directors. The majorities required by these two bodies depend upon the type of issue to be decided. One type (which for want of a better description we shall denote as issues of procedure) requires a 70% majority in the relevant voting body. This rule was left virtually unchanged by the new amendments. Another class of issues (which we shall denote as issues of substance) required usually an 80% majority under the old rules and requires an 85% majority under the new ones.² The re-

² The "issues of substance" (requiring now an 85% majority) include, for instance, adjustment of quotas, amendments to exchange rate arrangements, disposition of the Fund's gold reserves, allocation and cancellation of Special Drawing Rights, expulsion of members, or changes in the size or composition of the Executive Board. The "issues of procedure" (requiring a 70% majority) refer to transfers or assets between separate accounts within the IMF, determination of service charges as well as rates of charge or remuneration on members' liabilities to or claims on the Fund, establishment and termination of certain facilities within the Fund, and many administrative matters.

quired majority for deciding issues of substance was raised from 80% to 85% at the insistence of the United States to retain its veto power: the United States made this change a pre-condition for its agreement to having its voting share lowered from above to below 20% of the total vote.

II. Power and Power Indices

Power is an elusive concept whose full meaning is not quite clear. In voting bodies and other institutions, power usually means the ability of members or coalitions of members to make decisions unilaterally that are binding on the entire organization. In other words, power is the ability to influence outcomes. In order to measure this ability, game theorists and other social scientists have constructed various power indices, all of which measure the ability of players to influence the outcomes of the voting bodies they belong to.

To make this more precise, let us discuss one commonly used power index, the Banzhaf index, of which we made use in this paper. First, let N be the set of voters in a voting body indexed $i = 1, \dots, n$ and let $w = (w_1, \dots, w_n)$ be a vote distribution normalized such that $w_i \geq 0$ and

$\sum_{i=1}^n w_i = 1$. The voting body is then fully described

by an $(n + 1)$ -tuple $v = (d; w_1, \dots, w_n)$, where d is the decision rule of the body indicating the minimum fraction of the total vote that must be exceeded for the voting body to take collective action binding on all members, and (w_1, \dots, w_n) is the vote distribution. Let S be any subset of voters $S \subset N$. Then we can define the value of a coalition S as

$$V(S) = 0 \text{ if } \sum_{i \in S} w_i < d$$

$$V(S) = 1 \text{ if } \sum_{i \in S} w_i \geq d.$$

A voter is "critical" in a coalition S if his defection from that coalition changes the coalition from a winning to a losing coalition (i.e., $V(S) = 1$ and $V(S - i) = 0$).

The Banzhaf power index for member i is then defined as

For a complete enumeration of decisions requiring special majorities see IMF (1976), pp. 79 et seq.

$$P_B^i = \frac{\sum_S [V(S) - (S - i)]}{\sum_j \sum_S [V(S) - V(S - j)]}$$

This index, then, describes the number of critical defections of member i relative to the number of critical defections of all members. It follows that

$$\sum_{i=1}^n P_B^i = 1.$$

For instance, say, we have a voting body represented by the vector $v = (70; 50, 25, 25)$, where 70 is the decision rule and 50, 25, 25 are the voting weights associated with voters 1, 2, and 3, respectively. Five different coalitions can be formed in which someone is critical: voter 1 is critical in three of them (1,2; 1,3; 1,2,3), while voters 2 and 3 are critical in only one coalition each (1,2; and 1,3; respectively). Consequently, for this body, the power indices for voters 1, 2, and 3 are

$$P_B^1 = 3/5, P_B^2 = 1/5, P_B^3 = 1/5.$$

There are other voting power indices. The most common, the Shapley-Shubik index,³ while not always agreeing with the Banzhaf index, has been shown by Fischer and Schotter (1978) to exhibit similar power paradoxes. Another index, the Coleman index, is merely a linear transformation of the Banzhaf index. Other analyses of voting power, namely, one by Luce and Rogow (1956) take account of coalitional affinities among the voters displayed prior to the voting, while Owen (1975) has devised a method of constructing an index of the voters' power that allows for the possibility of certain coalitions being more likely to form than others. Consequently, while the Banzhaf index is restrictive and fails to incorporate such things as voter affinities, etc., it does have the advantage of being widely used and possessing an intuitively appealing interpretation.

³ Fischer and Schotter (1978) demonstrate that it is possible for the "paradox of redistribution" to occur when the Shapley-Shubik index is used and not to occur when the Banzhaf index is used in analyzing specific changes in voting distributions.

III. The Consequences of Quota Changes

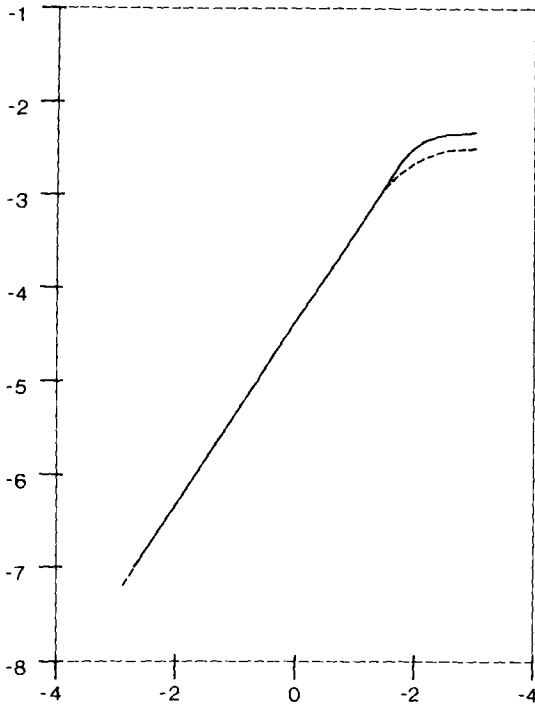
A. Previous Power Distribution

Before we investigate the consequences of the recent changes in the voting rules, distribution of voting weights, or the shares of the members of the IMF, let us first investigate the power relationships existing prior to April 1, 1978. These are reflected by solid curves in diagrams 1 through 4. These diagrams reveal several interesting features. (For the figures underlying these diagrams, see Dreyer and Schotter (1978) or contact the authors directly.) First, from the solid curve in diagram 1, we see that when individual countries voted on issues employing the 70% decision rule, the relationship between power and voting weights was practically log-linear except for the two largest countries, the United States and the United Kingdom, for which the relationship flattened out considerably. For issues involving the 80% rule (see the solid curve in diagram 2) the linear relationship failed to hold for the ten countries with largest voting shares: United States, United Kingdom, Federal Republic of Germany, France, Japan, Canada, Italy, India, Netherlands, and Australia. This result is interesting since votes are allocated on the basis of a country's contribution to the Fund's General Account. Consequently, say in the 80% case, while all countries may have claimed to be getting their "money's worth" in terms of power, this could not be said for the United States and the United Kingdom. For instance, while the United States contributed about 4 times as much to the Fund as West Germany did, it received only approximately 3% more of the power, as measured by the Banzhaf index, for that contribution.⁴

Similar results hold for issues that were voted upon by Executive Directors (see the solid curves in diagrams 3 and 4), again with the concavity more pronounced for issues involving the 80% decision rule than for issues involving the 70% rule. In this voting body, however, the United States had relatively more power than it

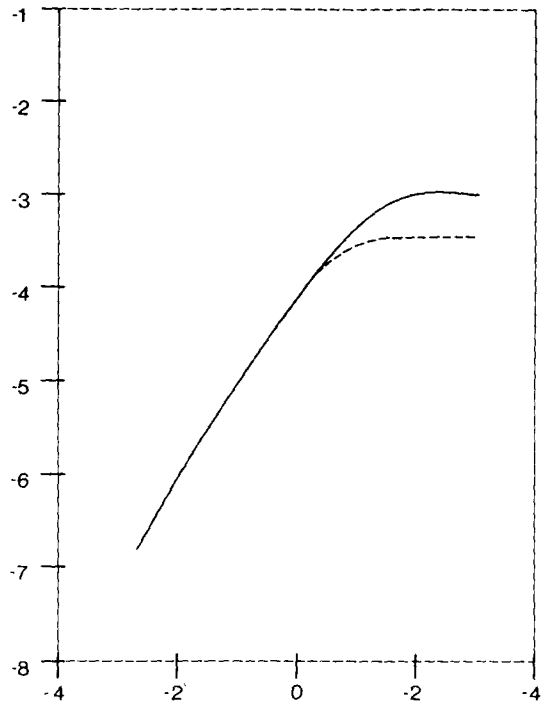
⁴ Olson and Zeckhauser (1966) demonstrate, through a model that describes the services of international organizations (such as N.A.T.O. or the U.N.) as public goods, that in most such organizations larger countries (notably the United States) wind up making a disproportionately large contribution to the financing of the organization.

DIAGRAM 1.—THE RELATIONSHIP BETWEEN VOTING WEIGHT AND VOTING POWER UNDER PREVIOUS (—) AND CURRENT (---) QUOTAS



Note: Logs of weights (horizontal axis) vs. logs of Banzhaf power indices (vertical axis). The body of Governors voting on issues requiring a majority of 70%.

DIAGRAM 2.—THE RELATIONSHIP BETWEEN VOTING WEIGHT AND VOTING POWER UNDER PREVIOUS (—) AND CURRENT (---) QUOTAS



Note: Logs of weights (horizontal axis) vs. logs of Banzhaf power indices (vertical axis). The body of Governors voting on issues requiring a majority of 80% and 85% under previous and current rules, respectively.

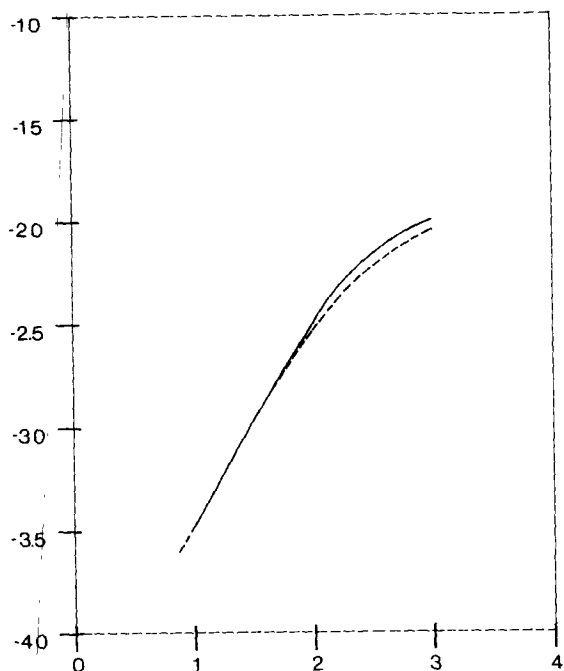
did in the voting body consisting of Governors. E.g., on issues involving the 70% decision rule, the United States had 13.54% of voting power in the body consisting of Governors as opposed to 9.07% within the Executive Board. In other words, the United States' power within the Fund increased when the other countries voted in blocks rather than separately. This seems somewhat counter-intuitive, of course, since one would expect that a "large" member would be hurt by the formation of syndicates, each of which would act in unison on particular votes. However, as several recent studies in game theory have shown (see Aumann (1973), Postlewaite and Rosenthal (1974), and Schotter (1979)), syndication need not always be advantageous for the members who syndicate and the Fund's Executive Board is an example of this phenomenon.

To present a picture of past power relationships in the IMF from a different angle, consider the "power Lorenz curves" (the solid curves in

diagrams 5 to 8) constructed to represent the degree of inequality of the distribution of power among Executive Directors and individual Governors in the IMF for issues involving the 70% and 80% decision rules.

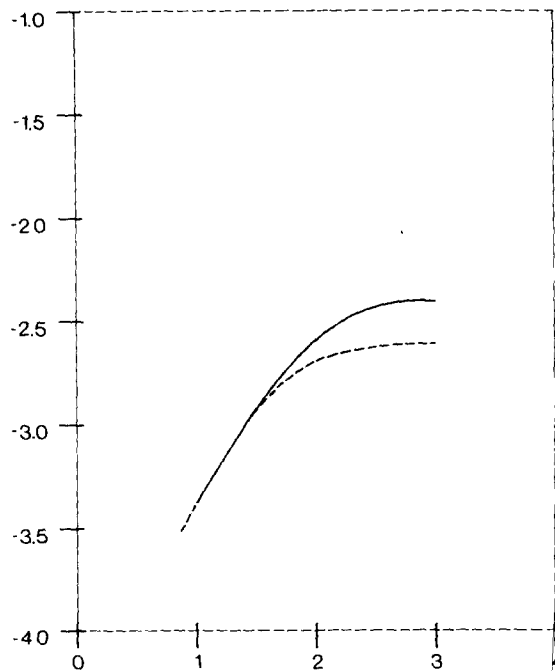
In all of these diagrams, the cumulative percentage of the voting weights is plotted against the cumulative percentage of the voting power. As we might expect from our previous discussion, since large countries had voting powers that were less than proportional to their voting weights, the resulting Lorenz curves should demonstrate a certain over-representation for smaller countries and this is indeed what we see. The diagrams clearly show that the inequality of power in the favor of smaller countries was more pronounced on issues requiring 80% of the total vote than on issues calling for a 70% majority. As we would expect, the inequality diminished when countries voted through their Executive Directors instead of individually, which is easily ex-

DIAGRAM 3.—THE RELATIONSHIP BETWEEN VOTING WEIGHT AND VOTING POWER UNDER PREVIOUS (—) AND CURRENT (---) QUOTAS



Note: Logs of weights (horizontal axis) vs. logs of Banzhaf power indices (vertical axis). The body of Executive Directors voting on issues requiring a majority of 70%.

DIAGRAM 4.—THE RELATIONSHIP BETWEEN VOTING WEIGHT AND VOTING POWER UNDER PREVIOUS (—) AND CURRENT (---) QUOTAS



Note: Logs of weights (horizontal axis) vs. logs of Banzhaf power indices (vertical axis). The body of Executive Directors voting on issues requiring a majority of 80% and 85% under previous and current rules, respectively.

plained by the increase in power of large countries on issues requiring Executive Directors' votes.

B. Consequences of Quota Changes

1. *Some Surprises:* When we analyze the consequences of the recent quota adjustment, we find some surprises and some expected results. Among the surprises are the paradoxical results described before. Specifically, some of the changes in power relations resulting from the quota adjustment are of opposite direction from the corresponding changes in voting weights. These paradoxical results are summarized in tables 1 and 2 where we see (in table 1) that, as a result of the quota changes, 38 countries have their percentage of power increased within the Fund even though their voting share decreased, while 4 countries (table 2) have their percentage of power decreased even though the new vote

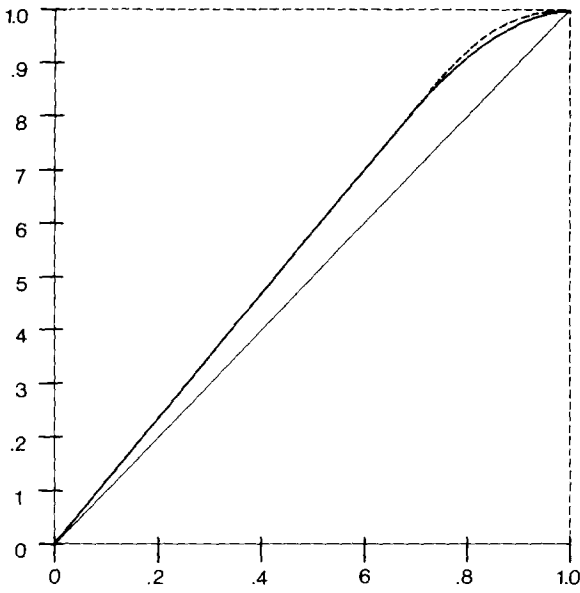
distribution awards them a larger share of the total vote.⁵ This result is not surprising to students of voting power since the power of a member depends not only on the number of votes or percentage of the total vote that he has, but also on the distribution of the remaining votes amongst the other $n - 1$ voters. For instance, consider the following example offered by Fischer and Schotter (1978):

Let $V = (70/100; 55/100, 35/100, 10/100)$ be a voting body where 70/100 is the decision rule and (55/100, 35/100, 10/100) is the vote distribution. The Banzhaf index associated with this distribu-

⁵ Since we are dealing with a very large voting body, it is not surprising that many of our results hold true only at a third decimal place; many countries have virtually no power to start with. However, the qualitative result still holds: increases or decreases in voting percentages do not necessarily imply increases or decreases in corresponding voting powers.

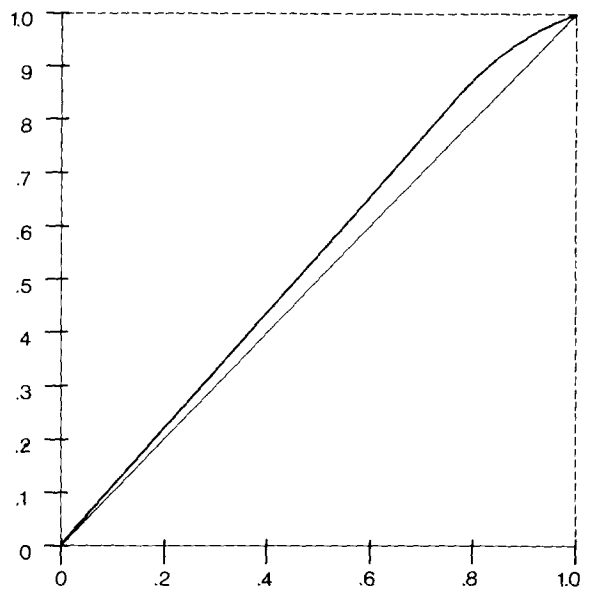
Our computations are based on the IMF membership as of December 31, 1976, consisting of 128 members. Since then the IMF membership has risen to 134 countries.

DIAGRAM 5.—POWER LORENZ CURVES



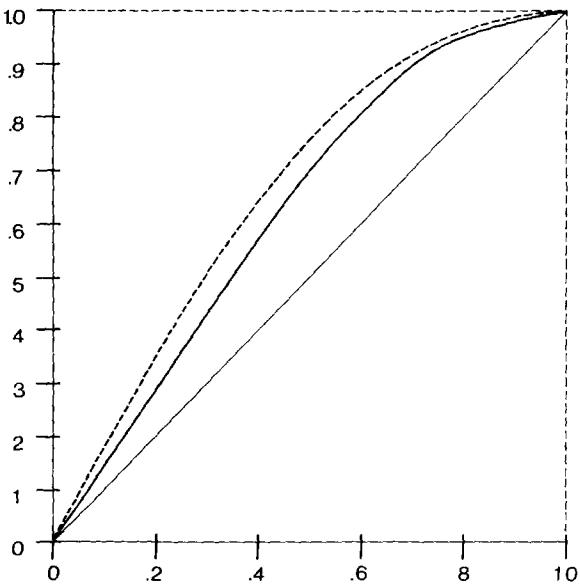
Note: Cumulative voting weights (horizontal axis) vs. cumulative Banzhaf power indices (vertical axis) under previous (—) and current (---) quotas. The body of Governors voting on issues requiring a majority of 70%.

DIAGRAM 7.—POWER LORENZ CURVES



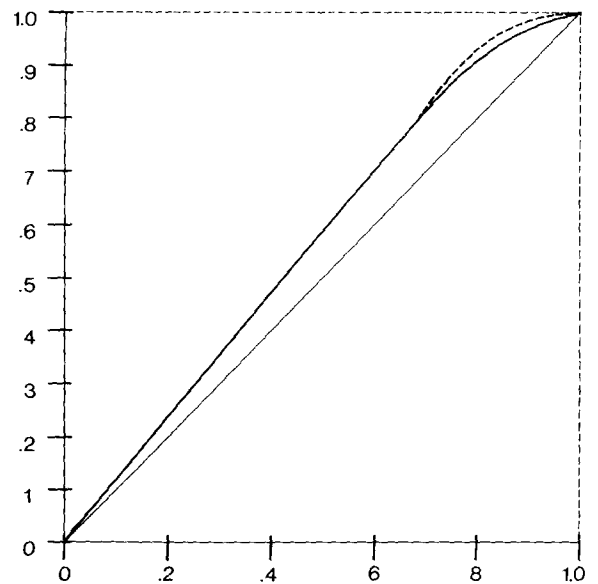
Note: Cumulative voting weights (horizontal axis) vs. cumulative Banzhaf power indices (vertical axis) under previous (—) and current (---) quotas. The body of Executive Directors voting on issues requiring a majority of 70%. (The power Lorenz curves under previous and current quotas coincide).

DIAGRAM 6.—POWER LORENZ CURVES



Note: Cumulative voting weights (horizontal axis) vs. cumulative Banzhaf power indices (vertical axis) under previous (—) and current (---) quotas. The body of Governors voting on issues requiring a majority of 80% and 85% under previous and current rules, respectively.

DIAGRAM 8.—POWER LORENZ CURVES



Note: Cumulative voting weights (horizontal axis) vs. cumulative Banzhaf power indices (vertical axis) under previous (—) and current (---) quotas. The body of Executive Directors voting on issues requiring a majority of 80% and 85% under previous and current rules, respectively.

TABLE 1.—OCCURRENCE OF THE PARADOX OF REDISTRIBUTION IN THE INTERNATIONAL MONETARY FUND: DECREASE IN VOTING WEIGHT RESULTING IN INCREASE IN POWER

Country	Previous Voting System $d = .80$		Current Voting System $d = .85$	
	% of Vote	% of Power	% of Vote	% of Power
Luxembourg	.14	.20	.13	.22
Papua New Guinea	.14	.20	.13	.25
Jordan	.15	.21	.13	.22
Honduras	.15	.22	.14	.23
Cyprus	.16	.22	.14	.23
Malagasy Republic	.16	.22	.14	.23
Ethiopia	.16	.23	.14	.23
Liberia	.17	.24	.14	.24
Yemen (P.D.R.)	.17	.24	.16	.25
Costa Rica	.18	.25	.16	.25
Cameroon	.19	.27	.17	.27
Guatemala	.19	.27	.18	.30
Panama	.19	.27	.17	.27
Bahamas	.14	.20	.13	.22
Dominican Republic	.21	.30	.19	.31
Kenya	.23	.33	.22	.37
Tunisia	.23	.33	.21	.34
Syria	.23	.33	.21	.34
Jamaica	.24	.35	.23	.39
Burma	.26	.38	.23	.39
Trinidad and Tobago	.27	.39	.25	.41
Uruguay	.29	.42	.26	.43
Sudan	.30	.43	.27	.44
Ghana	.35	.50	.31	.51
Sri Lanka	.38	.55	.34	.56
Iraq	.41	.60	.39	.64
Morocco	.43	.61	.41	.68
Zaire	.43	.61	.42	.69
Ireland	.45	.64	.43	.69
Peru	.46	.66	.45	.73
Bangladesh	.46	.67	.42	.66
Turkey	.54	.78	.53	.86
Egypt	.66	.94	.60	.97
Romania	.66	.95	.64	1.03
Pakistan	.80	1.14	.73	1.17
Norway	.82	1.17	.76	1.20
Denmark	.88	1.25	.79	1.26
Austria	.91	1.29	.84	1.32

TABLE 2.—OCCURRENCE OF THE PARADOX OF REDISTRIBUTION IN THE INTERNATIONAL MONETARY FUND: INCREASE IN VOTING WEIGHT RESULTING IN DECREASE IN POWER

Country	Previous Voting System $d = .80$		Current Voting System $d = .85$	
	% of Vote	% of Power	% of Vote	% of Power
Belgium	2.08	2.76	2.17	2.62
Netherlands	2.24	2.92	2.30	2.68
Japan	3.78	4.06	3.99	2.99
Germany (Fed. Rep.)	5.01	5.39	5.16	3.01

and (2 and 3). In other words, he is now "critical" in more coalitions than he was before. (For a further theoretical discussion of these results, see Fischer and Schotter (1978).)

2. *Power Effects*: If we were to give a general assessment of the recent changes, we could state that under the new distribution of voting weights larger countries have unequivocally less power than they had under the old distribution. This fact is demonstrated in diagrams 1-4, where we superimpose the voting power/voting weights relationship under the new scheme over the relationship we found under the previous scheme.

The overall impression from these diagrams is that the recent changes did not drastically alter the basic relationship between voting weight and voting power. There is a universal tendency for the power of the large countries to be less than proportional to their voting shares and this tendency is more pronounced for issues of substance than it is for issues of procedure.

When we superimpose our power Lorenz curves constructed for the new rules and distribution of voting shares over the Lorenz curves obtained previously (see dashed curves in diagrams 5-8), we see that there is practically no change in the degree of power inequality in the Fund except for issues of substance voted upon by Governors. In fact, for the body of Executive Directors, the Lorenz curves for the 70% voting rule under the new system coincides with the Lorenz curve generated under this rule for the old system. (See diagram 7.) For issues of substance, however, power is further redistributed in favor of the smaller countries.

To summarize our results, the recent changes in the voting rules and distribution of voting shares in the International Monetary Fund have somewhat increased the power of its smaller

tion is (1/2, 1/2, 0). Now, redistribute the votes to obtain the following distribution:

$$V' = (70/100; 50/100, 25/100, 25/100).$$

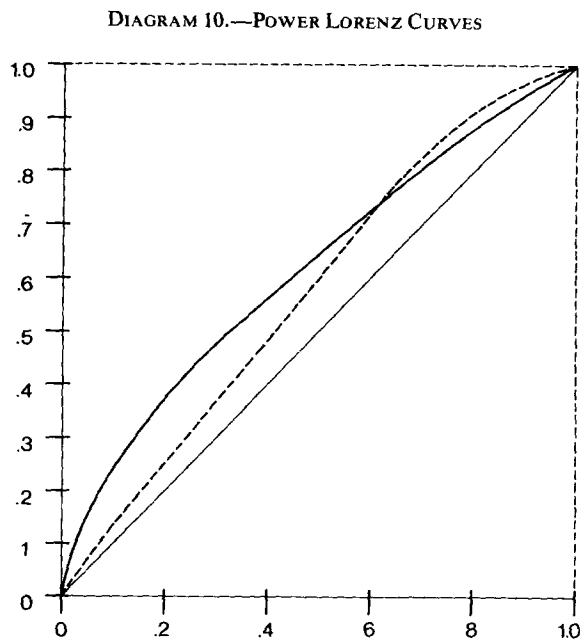
Here, the Banzhaf index is (3/5, 1/5, 1/5). We see that voter 1 has had his power increased though his percentage of the vote has decreased by 5%. This is not a peculiarity of the index, however, since voter 1 is actually more powerful after the change than before: he can now form a coalition with players 2, 3 and (2 and 3), and secure the desired outcome, whereas before he could win only by joining forces with players 2

members. In addition, in many instances these changes have produced outcomes opposite to the intentions of the drafters of the quota redistribution scheme.

C. World Trade Shares and Power within the IMF

One purpose of periodic adjustments in the IMF members' quota is to bring in line a member's quota with its importance in the world economy. To see if this purpose was achieved, we investigated the relationship between the share of any particular country in total exports of all IMF members and its power within the organization. These relationships are presented as a set of two power Lorenz curves (diagrams 9 and 10) for 80% decision rules.

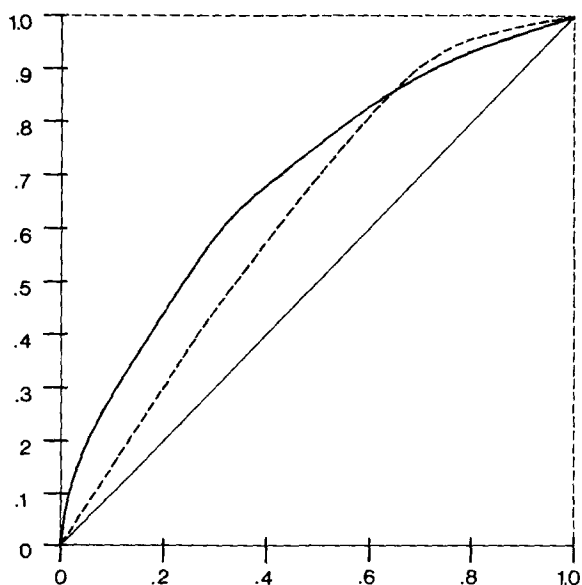
These diagrams demonstrate that for the smaller countries, export shares are even worse proxies for power within the Fund than are their voting weights, that is, the distribution of power is even more biased in favor of the smaller countries when the members' trade shares, instead of voting weights, are used as a yardstick. In addition, if we compare power Lorenz curves under previous rules and quotas with the ones that re-



Note: Cumulative export shares (—) and cumulative voting weights (---) vs. cumulative Banzhaf power indices (vertical axis) under previous quotas. The body of Executive Directors voting on issues requiring a majority of 80%.

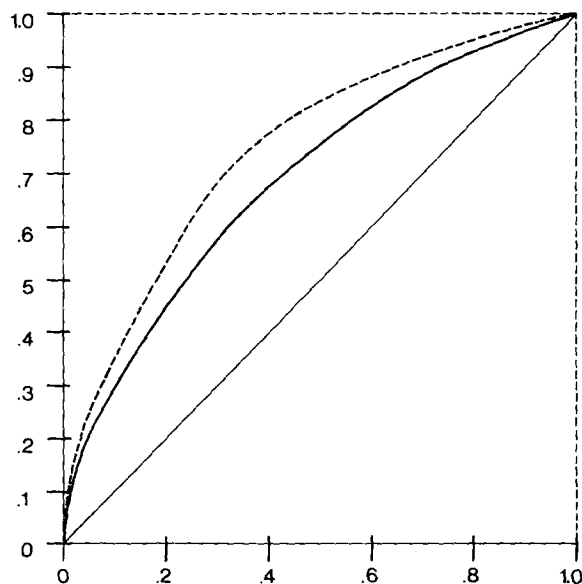
sult from the recent change, we see that this bias has become magnified (diagrams 11 and 12).

DIAGRAM 9.—POWER LORENZ CURVES



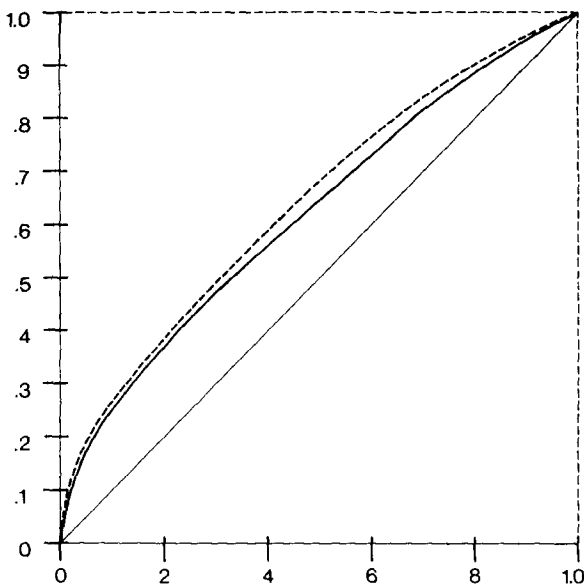
Note: Cumulative export shares (—) and cumulative voting weights (---) vs. cumulative Banzhaf power indices (vertical axis) under previous quotas. The body of Governors voting on issues requiring a majority of 80%.

DIAGRAM 11.—POWER LORENZ CURVES



Note: Cumulative export shares (horizontal axis) vs. cumulative Banzhaf power indices (vertical axis) under previous (—) and current (---) quotas. The body of Governors voting on issues requiring a majority of 80% and 85% under previous and current rules, respectively.

DIAGRAM 12.—POWER LORENZ CURVES



Note: Cumulative export shares (horizontal axis) vs. cumulative Banzhaf power indices (vertical axis) under previous (—) and current (---) quotas. The body of Executive Directors voting on issues requiring a majority of 80% and 85% under previous and current rules, respectively.

IV. Implications and Conclusions

It is clear that a quantitative analysis of a voting system provides us with a singular perspective from which to view the power relationships in an institution. We are well aware that there are many more facets to power relationships than can be represented by power indices. In any voting assembly, and certainly in the IMF, where decisions are reached through informal consensus rather than by formal vote, behind-the-scene activity and understandings resulting from it play a crucial role in adopting collective decisions.

Analysis of power relationships as reflected in power indices, although admittedly limited in scope, appears to be demonstrably superior to contemplation of voting shares. While it is true that equity or fairness cannot be reflected adequately by numbers, power indices still remain the best quantitative tool available in assessing the soundness of many political structures.

With these caveats in mind one may be tempted to draw some implications of recent changes

in rules and quotas for power relations in the IMF. It is obvious that voting shares do not reflect properly members' voting powers. Generally, increases in members' voting shares result in less than proportional increases in their voting powers and not infrequently, an increase in a member's voting share is translated into a decrease in his voting power. While this "paradox of redistribution" is unavoidable, its consequences ought to be taken into account when contemplating future redistribution of quotas (voting shares) at the IMF. It should also be borne in mind that voting powers of individual members may be substantially different depending on whether the decision is to be made by the Executive Board or the Governors.

More important, our results raise a fundamental question about the desirability of using quotas as an appropriate basis for determining member countries' influence or power in the Fund. Under the previous as well as amended Articles of Agreement the members' quotas serve several purposes. The use of quotas for determining the members' access to credit tranches and financial facilities may be justified as conforming to "prudent banking principles," even though the connection between a country's quota and its credit worthiness is rather tenuous. Using quotas for the purpose of establishing the Fund members' entitlements to periodic allocations of Special Drawing Rights is even more arbitrary; certainly, a case can be made for distributing to poorer countries (having, as a rule, smaller quotas) international means of payments more than in proportion to their IMF quotas. Regarding the countries' influence in the Fund, it can be argued that in assigning members' voting shares the relationship between these shares and the underlying quotas be specified in such a manner as to weaken the effect of non-linearities reflected in diagrams 1 through 4. On the other hand, it is not unreasonable to maintain that, on the basis of equity, the influence in the Fund of its smaller members is still insufficient in spite of their enjoying disproportionately great power relative to their voting shares.

Apart from these value judgments, however, our results suggest that in deciding on future redistribution of quotas, the relationship between voting power indices, not just between voting shares, ought to be the focus of concern and attention of the negotiating parties.

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