Bloc Concentration and the Balance of Power

THE EUROPEAN MAJOR POWERS,
1824-1914

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This article argues that a better trace of the operation of a balance of power system can be obtained if two dimensions, alliances and capabilities, are combined into a single measure of bloc concentration. After reviewing the basic features of a balance of power system to show why this is the case, such an index is constructed. Several patterns of bloc concentration consistent with the operation of a balance of power system are derived and examined, using data for the European major powers from 1824 through 1914, and for all the major powers from 1919 through 1965. The findings are consistent with the existence of a balance of power system in the earlier era and with a form of balancing behavior in the post-World War I era.

Of all the concepts utilized in international politics, none is more controversial than balance of power. Arguments have raged across the centuries on every conceivable issue connected with it. Of course, much of the difficulty is a result of the various meanings that have been attached to the term (for two enumerations of these different meanings, see Haas, 1953; Claude, 1962). Thus, many discussions feature scholars with different conceptions of balance of power arguing past one another. And yet, despite all of this confusion, balance of power is still the starting point for much of the literature in international politics. For example, the most well-known text in the field is explicitly organized

AUTHOR'S NOTE: Data used in this article were made available to me by the Correlates of War Project at the University of Michigan. Responsibility for analysis and for any errors is mine alone.

JOURNAL OF CONFLICT RESOLUTION, Vol. 28 No. 1, March 1984 25-50
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around it (Morgenthau, 1974), and, for the policymaker, movements to balance and counterbalance various nation-states are still seen as highly relevant; the debate over the use of the so-called "China card" by the United States is the most recent example.

Not surprisingly, a number of efforts have been made to tease the central propositions out of this literature and to test them empirically. One set of studies considers general arguments about alliance configuration—usually in terms of alliance polarity—and its relationship to war (e.g., see Singer and Small, 1968; Wallace, 1973; Bueno de Mesquita, 1975; Haas, 1970; Thompson et al., 1980). These works shed indirect light on the question of whether a balance of power system existed for certain periods of time. Some empirical work has also been done on the link between capability and war (Singer et al., 1972; Organski and Kugler, 1980); the findings of these studies are mixed with regard to the existence of a balance of power system.

Most quantitative efforts have dealt with patterns of alliance formation and/or dissolution within the major power system (McGowan and Rood, 1975; Job, 1976; Siverson and Duncan, 1976; Li and Thompson, 1978; Baumann, 1981; Midlarsky, 1981). On the whole, these studies find some support for the existence of a balance of power system in the 1800s.

It is my contention that a key concept of a balance of power system has been overlooked in these efforts; that it is neither the patterns of alliance bonding nor the capability distribution across individual nations that characterizes a balance of power system, but rather the combination of these two attributes into the single concept of bloc concentration that most accurately captures the behavior of such a system. The tasks of this article are:

- (1) To describe the general features of a class of balance of power system, and to show how bloc concentration relates to these features.
- (2) To construct an empirical measure of bloc concentration and to determine whether its distribution across time supports the existence of a balance of power system among the major European powers from 1824 through 1914, and among all major powers from 1919 through 1965.

BALANCE OF POWER AS SYSTEM

It would be folly to suggest that any single piece of research could resolve the debate about the meaning of the phrase "balance of power"

and achieve a synthesis that would be acceptable to all the scholars who have spoken, written, or thought about it. Nevertheless, I will try to bring a measure of order out of the chaos of assertions about it and to develop a set of expectations concerning behavior in a certain class of balance of power system. In the system to be described below, power is viewed as an extremely fungible quantity that can be used by a government in pursuit of its national interests. Although this abstraction breaks down in any real world application, it is consistent with much of the previous work on the subject and represents a useful starting point for theoretical development.¹

To achieve this goal, I first limit the meaning of the phrase “balance of power” to what Claude (1962: 20-25) has called balance of power as a system:

not a certain type of power configuration, or a certain precept of policy, but a certain kind of arrangement for the operation of international relations in a world of many states.

Although this definition significantly narrows the range of meanings of the phrase, it certainly does not eliminate all the ambiguities. I now turn to the task of considering why fluctuations in a composite measure of alliances and capabilities are a valid indicator of the operation of a balance of power system.

POWER, BALANCES, AND EQUILIBRIUM IN A BALANCE OF POWER SYSTEM

The behavior of a balance of power system is the result of the interactions among the nation-states that are the actors in the system. System-level behavior is an emergent property of this interplay and need not be the result of a conscious design on the part of any actor. For the purposes of this article, each nation-state is assumed to consist of a government and of the quantity of power contained within the state. I assume that each government is a unitary rational actor that seeks to maximize the national interest of the country. The most important element of this national interest is the survival of the nation-state. Beyond this core value, a large number of items could be part of the national interest of a particular nation-state. But, regardless of the specific content of a nation's national interest, the main instrument available for pursuit of these goals is the power of the nation-state

1. This section of the article is based heavily on the discussions of balance of power in Claude (1962), Gulick (1955), and Waltz (1979).

vis-à-vis the other nations in the system—that is, its relative power. The reason is simple: In a nation-state system characterized by decentralization and anarchy, a government must ultimately fall back on its own abilities to attain its goals. And possession of large quantities of power provides a government with the wherewithal to exercise some control over its environment.

So what is the emergent system-level behavior of a group of nation-states operating in the manner described above? We should expect that, from time to time, some governments (either acting individually or in concert) will increase their relative power in order to maximize their self-interests. These actions, in turn, will result in a concentration of power in the hands of this nation-state (or these nation-states). But self-interest on the part of other nation-states participating in the system will result in any concentration of power being offset within a short period of time. Thus, a balance of power system should be characterized by periodic large-scale disruptions in the equilibrium of the power distribution followed by movement back toward that equilibrium. To reiterate, power gains are not necessarily the ultimate goal of a government but can serve as a very important tool to achieve other objectives. Nevertheless, the ebbs and flows of a balance of power system should be traceable by following the distribution of power in the system through time.

POWER ACQUISITION IN A BALANCE OF POWER SYSTEM

Given the preceding discussion, it is quite clear that governments in a balance of power system can be expected to place a high premium on the acquisition of power for their nation-states, or, equivalently, to deny or reduce the power of other nation-states in the system. Since the primary variable to be used in this study is an indicator of the distribution of power among the groupings of nation-states in the system, a digression on the major options available to governments for power enhancement is necessary to make clear the rationale for the composition of the indicator.

Government policy choices for power enhancement fall into two general categories: internal and external. Internal policy choices are

efforts by a government to increase its power through actions taken within its boundaries. These measures would include, of course, policies designed to increase the military strength of a nation. But government actions to increase more general types of resources—industrial or demographic resources, for example—can also be expected, since in addition to boosting the military capability of a country, these can be useful tools in their own right.

External policy choices to enhance power involve a government's efforts outside its boundaries. A large number of options are available; space precludes an extensive discussion of each major possibility (see Gulick, 1955: 52-94), but some brief comments are in order. Governments can acquire power from other nations through a variety of methods; for example, they can annex territory, demand compensation from other powers, or coerce resources by means of threats.

A more controversial option is to go to war. Although a short successful war can result in a power gain for the victor, it is a risky strategy that may result in a net loss of power. For this reason, I would expect that wars would be a rarely used tool for power enhancement. Some scholars take this argument a step further and assert that a balance of power system should experience no war; therefore, any outbreak should be taken as evidence against the existence of such a system (Organski, 1968: 281). But I believe that wars can be a tool of governments in a balance of power system, albeit an infrequently used one.

A final option, frequently discussed in the balance of power literature, is the formation of an alliance between two or more nations to pool their power into a single grouping. Such an action can result in an immediate increase of power for the participating governments.

To summarize, governments have a multiplicity of choices to enhance their own power and/or reduce the power of other nations. This poses problems for researchers investigating the balance of power. Predicting the particular instrument to be used by a government may be a very difficult task; the choice may turn on a collection of factors unique to the situation at hand. However, we can generalize about the balance of power if we step back and deal not with the specific policy choices of governments, but with the results of their actions—the above-mentioned fluctuations in the distribution of power caused by the gains and losses of power among groupings of nation-states in the systems.

BLOC CONCENTRATION AND THE BALANCE OF POWER

Let me now introduce the concept of bloc concentration, draw the links between it and the preceeding description, and introduce the pattern of bloc concentration values expected in a balance of power system.

Bloc concentration is defined as the extent to which national capabilities are concentrated or diffused among the groupings of nation-states in the system. The word "grouping" is used to denote either a cluster of nation states that are bonded together or a single nation state that stands alone. Bloc concentration is an important concept in a balance of power system because it covaries with the ebb and flow of the system's power equilibrium. Disequilibrium begins when a nation-state (or grouping of nation-states) threatens to become inordinately powerful. If this threat is actualized through the use of one or more of the policy choices described above, the distribution of power within the system should become concentrated in the hands of the grouping of nation-states seeking preponderance. The power equilibrium is restored if the countermoves of another grouping of nation-states result in a less concentrated distribution of power in the system. This change in distribution of power among the groups should be captured in the movement of an index of bloc concentration. Not every disequilibrating action and equilibrating counteraction would be reflected in an index of bloc concentration. For example, if a nation extracts a concession merely by threatening action, this would not be reflected in the value of the bloc concentration index. But large-scale moves and countermoves within the system will be reflected in the index.

The first pattern of bloc concentration that I expect in a balance of power system stems from the moves and countermoves outlined above; in a balance of power system, we expect to observe repeated alternations of high and low levels of bloc concentration as disequilibrium (high levels of bloc concentration) followed by countermoves that lead back to equilibrium (low levels of bloc concentration). Formally, the first pattern I expect is:

P1: Bloc concentration levels will be related to one another over time. Extreme levels, high or low, will be followed by more moderate (less extreme) levels.

Three points should be noted about this expectation. First, for reasons stated above, when the level of bloc concentration is high, an

operating balance of power system should result in the succeeding values being lower. Second, given the constant vigilance maintained by governments in a balance of power system (Gulick, 1955: 53-58), the shifts in bloc concentration should occur rather quickly.

The third point deals with the expected relationship between a low level of bloc concentration, and its succeeding values. Would we expect that such low levels would be followed by high levels (i.e., is the expected relationship between extreme values of bloc concentration and succeeding values symmetric, regardless of the direction of the extreme value)? Some upward shift from low levels would be expected for two reasons. First, if the level of bloc concentration is low, then any change in power or alignment can be expected to produce a higher level of bloc concentration; there is no other place for it to go. Second, some increase in bloc concentration may be tolerated, although not necessarily encouraged, by the other nation-states in the system. Small increases may not produce a level of bloc concentration that is considered to be a threat to the system. The first expected pattern implies that the effects of extreme levels of bloc concentration are symmetric and that estimating the relationship between adjacent bloc concentration levels will produce an "average" effect of current bloc concentration levels on succeeding ones. Thus, if the effect of low levels of bloc concentration on succeeding levels is not as strong as the effect of high levels on subsequent levels, the results will be weaker than if the asymmetric effects were tested separately. To ascertain whether these asymmetries exist and whether they are consistent with the existence of a balance of power system, the following two expectations will also be examined:

P2: Extremely high levels of bloc concentration will be followed by a drop in bloc concentration.

P3: Extremely low levels of bloc concentrations will not be followed by any systematic change in bloc concentration.

THE DOMAIN OF THE STUDY

To explore these expectations, I will first examine bloc concentration among the major European powers from 1824 to 1914. Although data exist to construct the bloc concentration index back to 1816 (see below), the Concert of Europe existed from that time through 1823. Historically, the Concert was a bond that tied together all the major powers; the

meaning of bloc concentration in this situation is not clear. On a more practical note, the procedure used to construct the bloc concentration index produces an undefined value when only a single grouping of major powers exists. Since the index construction and the diplomatic historians' interpretation of the time period lead to the same conclusion, I feel justified in dropping it from consideration.

As for the ending date, the outbreak of World War I is commonly considered to denote the end of the European balance of power system that had existed for at least the previous century. This date also closely matches much of the other statistical work cited above that deals directly or indirectly with the balance of power.

The major European powers were chosen for analysis because they constituted the oligarchy of powerful states that are most often considered to have participated in a balance of power system during this time period.

I will also extend the analysis beyond World War I, and consider the pattern of bloc concentration values for the entire 1824-1965 time period. This extension incorporates one period of time during which the existence of a balance of power system is open to question (1919-1939), and a second period in which a balance of power system did not exist (1946-1965).

This temporal extension poses problems at several different levels. First, capability data are impossible to obtain for the years of the two World Wars; this introduces some complications for the data analysis techniques to be used and will be discussed below. A second problem concerns the shifting composition of the major power system. Although Singer and Small identify the entry of two non-European major powers in the pre-World War I era (Japan in 1895 and the United States in 1899), previous empirical research on the balance of power, as well as the conventional diplomatic interpretation of the post-Napoleonic era, would argue for the restriction of the analysis to the European major powers. But in the post-World War I era, there is no plausible reason to exclude them. Therefore, all Singer and Small major powers will be used for the post-1918 analysis (for an enumeration of all the major powers and their years of membership, see Singer and Small, 1972).

The introduction of non-European major powers and significant changes in the governments of several of the European major powers raise some questions about the bloc concentration patterns discussed above. Would we expect that despite the shifting composition of the major power system, the "common culture" of the pre-World War I system would be preserved? (Gulick notes that homogeneity of actors is an important assumption of the balance of power; 1955: 19-24).

Despite these changes to the major power system, I expect that the post-World War I system will maintain some of the same characteristics in bloc concentration patterns as the previous era. Governments will still act in their self-interests. From time to time, in pursuit of these interests, major powers will still try to gain a power advantage over their peers. This will result in a concentration of power in their bloc. And other states, acting in their own self-interests, can be expected to launch countermoves that will result in the restoration of the system's power equilibrium (i.e., a lower value for bloc concentration).

In other words, the post-World War I era does not signify the end of political realism as a set of informal guidelines for policy makers. But what, then, can be expected to change in these latter periods? It is the ability of governments to use alliances as tools for power enhancement. The heterogeneity of the major power system in the post-World War I era will raise artificial barriers between various pairs of major powers, making alliances between them highly unlikely. The presence of certain unacceptable (or at least highly unlikely) pairs of nations occurs initially in the interwar era; it becomes more pronounced with the East-West split in the post-World War II world.

When the number of available alliance partners becomes restricted, this removes one of the quickest ways for a government to increase the power available to it. Given these restrictions, I expect that for the entire 1824-1965 era:

P4: Bloc concentration will show the same dampening pattern as in the pre-World War I era.

P5: High levels of bloc concentration will be followed by a drop in bloc concentration.

P6: Low levels of bloc concentration will not be followed by any systematic changes in bloc concentration.

But because of the restriction on the use of alliances as a tool for power enhancement, governments will have to rely on other policies to effect the power distribution in the system. Limiting the use of this very rapid means of power enhancement will result in fewer great swings in the value of bloc concentration; the rises and falls in the post-World War I era will be slower and less extreme. Consequently, I expect the following different pattern in the two eras:

P7: The variance of bloc concentration will be less in the 1919-1965 era than in the 1824-1914 era.

TEMPORAL AGGREGATION, DATA, INDEX CONSTRUCTION, AND ANALYSIS TECHNIQUES

To test the hypotheses enumerated above, the concept of bloc concentration must be operationalized and then examined over time. But, first, it is necessary to select the period of temporal aggregation to be used.

TEMPORAL AGGREGATION

As discussed earlier, changes in national power (which affect the values of bloc concentration) can be generated either through internally or externally directed policies. Internal changes are generally reflected in national capabilities. Following earlier work by the Correlates of War Project, three dimensions of capability will be used to index national power; the three dimensions are the demographic, the industrial, and the military. With few exceptions, changes in these capabilities cannot be made quickly. Further, the "paper traces" of these capabilities are generally compiled only on a yearly basis. For both these reasons, an interval of a year between the measurement of internal capabilities seems adequate to tap major changes in their level.

But external policy choices also affect national power (and, therefore, bloc concentration), and the effects of these changes may show up in a length of time less than a year. For example, the average duration of an interstate war involving a European major power between 1824 and 1914 was 10.73 months (calculated from Singer and Small, 1972, Table 4.2). Clearly, the immediate effects of war on national power, for good or bad, may manifest themselves within a year. And while negotiations for the formation of an alliance may be protracted, it still seems likely that the use of a period of a year would obscure a portion of the alliance-based moves and countermoves that are the focus of hypotheses.² To minimize these problems, major power alliance configurations will be calculated for each six month period from the beginning of 1824 to the end of 1965, excluding the years of the two World Wars. So, although national capabilities will be measured only at the yearly level, the bloc concentration index will be calculated every six months.

The choice of the half year is, admittedly, arbitrary. But it represents a reasonable compromise between the overaggregation problems intro-

2. Six months was the most frequent period of time between major power alliance changes during the 1816-1914 period; about 31% of all such changes occurred during this interval (McGowan and Rood, 1975: 868).

duced by use of the year as the temporal unit of aggregation and the problem of artificial multiplication of the number of data points if an extremely small unit of temporal aggregation (say, the month) were to be used. As a practical matter, the use of the half year rarely led to the aggregation of two alliance changes into a single observation period.

DATA AND INDEX CONSTRUCTION

The construction of the bloc concentration index (hereafter BLOC-CON) for the major powers involves four steps:

- (1) Obtaining a measure of each major power's capability in each year.
- (2) Placing each major power in alliance-based cluster in each half-year.
- (3) Combining these two measures, so that each major power alliance cluster is weighted by the amount of capability and the degree of commitment of its members.
- (4) Calculating the concentration of capability across the weighted major power alliance clusters.

At each step of the measurement process, I relied on data and procedures developed by other researchers.

For the measure of major power capability, I used annual percentage capability scores. Data for these scores (and the measure itself) were developed by the Correlates of War Project. Singer et al. (1972) use the same measure, but their data were collected at five year intervals. Since that time, the data collection has been expanded to include annual data on each of the following six capability indicators: total population, urban population, military personnel, military expenditures, iron or (after 1895) steel production, and (after 1859 only) commercial energy consumption. This data set allows me to tap each of the three above-mentioned dimensions of capability (demographic, military, and industrial) with a pair of indicators.

A major power's capability was measured by combining the six indicators into a single value, called a percentage capability score. This score was calculated as follows: first, an individual major power's proportion of the major power total on each of the six indicators was calculated. Then each major power was assigned its average value across all six percentage scores. Equally weighting all the indicators is the most straightforward way of combining them in the absence of any well-defined theory that specifies a more complicated algorithm.

The next step in the index construction procedure was to calculate the groupings of major powers. These groupings were determined by

applying a clustering technique to the formal military alliance bonds between the major powers. An alternative to the use of a clustering technique was to place each major power in a cluster that included all the other major powers with which it shared an alliance bond. But this simple approach would have led to problems. For example, consider the major power alliance patterns that existed on the eve of World War I. Britain, France, and Russia were allied to one another, and Austria-Hungary and Germany also shared an alliance. But every one of these nations, except Britain, also shared an alliance with Italy. The result of the simple grouping procedure outlined above would be to place all of the major powers in the same bloc—clearly, a very counterintuitive result. A clustering algorithm allows for more subtleties in the determination of groupings of nation-states. Further, it permits a measure of distance for each major power from its cluster. This allows me to distinguish between nation-states that are tightly bonded to a cluster, and those that are only loosely tied to it. In fact, the distance measure can be used to weight the capability possessed by the cluster; tightening up existing alliance bonds within a cluster will lead to a growing concentration of capability within that grouping of major powers and, therefore, change the level of bloc concentration.

To determine the major power alliance-based clusters, I employed a procedure developed by Bueno de Mesquita (1975). It begins with the calculation of an alliance similarity score for each pair of major powers in each time period (here, every six months). The score is a tau B coefficient based on a four-by-four crosstabulation of each pair of major powers' formal alliance commitments to all major powers. The four possible types of alliance bond (from strongest to weakest) are: defense pact, neutrality pact, entente, and no formal military alliance. The resulting matrix of these alliance similarity coefficients is then subjected to a clustering algorithm known as typal analysis (McQuitty, 1957) so that the major powers can be grouped into clusters. The tightness (degree of bondedness) of each cluster is also calculated, using the tau B scores from the similarity matrix. For a more extensive description of the procedure, the reader is referred to the original article; the coding rules for the alliance data are given in Singer and Small (1968).

There are several points of difference between the procedure as applied by Bueno de Mesquita (1975) and in this analysis:

- (1) Only major power-major power alliance bonds were used to calculate alliance similarity scores between pairs of major powers.
- (2) The major power-major power alliance bonds were taken from Sabrosky's (1975) update of Singer and Small's original list of alliances.

- (3) If a major power had no major power alliance bonds during a six month time period, it was placed in a cluster by itself.

The first modification is due to the specific focus of this research: to study the system-level consequences of interactions between the major powers. I assume that the primary concerns of major power governments during this time period were other major powers. Additionally, during the years 1824-1940, the total percentage capability of the major powers was never less than 60% of the total percentage capability in the interstate system (Cusack, 1978: 18). Thus, the attachment or defection of minor powers to the major power clusters would have little effect on the capability of each major power cluster, so restricting my attention to only the major powers appears unlikely to distort the results.

Sabrosky's update of Singer and Small's alliance list contains one major ingredient missing from the original collection. It includes formal alliances that were consummated during wartime. Since I assume that the balance of power system continues to operate during wartime (with caveats concerning the two World Wars), any changes in major power alliances and hence bloc concentration during these periods are important to track.³

The final modification to Bueno de Mesquita's procedure was undertaken to insure that major powers with no alliances were not placed in a cluster with other major powers. Although it is unlikely, the clustering technique does not rule out this possibility. Two major powers may be considered similar because they share so many noncommitments and, given the bonding pattern of the remaining major powers, the two nonaligned states might be placed in the same cluster.

The capability weight for each cluster was derived by summing the percentage capability scores of each cluster's major power members and discounting this sum by the tightness of the cluster. Tightness is a measure also developed by Bueno de Mesquita. It can range from 0 to 1, with a "1" indicating that all members of the cluster are joined by a defense pact bond and have identical alliance bonds with all out-of-cluster major powers.

The final step of the indicator construction process is to measure the extent to which capability is concentrated or dispersed across the

3. The role of warfare in the balance of power system described here deserves some emphasis. Warfare is regarded as a tool (albeit an extreme one) for inducing changes in the power distribution of the system. That is, it serves as a means to an end. Consequently, the relevant effects of a war can be assumed to appear in a measure of bloc concentration and need not be handled in a separate manner.

weighted alliance clusters. For this, I use a measure developed by Ray and Singer (1973) that was first used by Singer et al. (1972).⁴ It is simply the observed standard deviation of the weighted cluster capability scores divided by the maximum possible standard deviation of these scores. This maximum would occur if one cluster contained all of the major powers' capability. The resulting BLOCCON index can range from 0 to 1, with a 0 indicating that the weighted capability is distributed evenly across all of the clusters and a 1 indicating that all the capability in the major power system is concentrated in a single bloc.

The BLOCCON index will change whenever the alliance bonding among the major powers is modified or the distribution of relative capabilities is altered in any way. It reflects such effects as rapid internal growth within a nation-state, the gains and losses of a war to its participants, and the changes in their military capabilities.⁵

METHODS OF ANALYSIS

Several statistical techniques familiar to most quantitative researchers will be used to examine the hypothesized patterns of bloc concentration noted above. The analysis will be performed first for the 1824-1914 period and then for the entire 1824-1965 period. In this way, the possible impact of changes in the major power system after the end of World War I can be observed.

Before indicating the technique to be used in the examination of each pattern, a brief mention should be made concerning ARIMA (auto-regressive-integrated-moving-average) modeling, since this may not be familiar to all readers. ARIMA modeling provides a way to both identify and estimate the dependence of a variable on its previous values.

4. An alternative to the use of an indicator based on this measure would be the use of one based on MOVE, another measure used by Singer, Bremer, and Stuckey. MOVE measures the extent to which relative capability shares are exchanged between nations (i.e., the size of the relative capability shift between nations or groups of nations). Such a measure reflects the gross amount of the capability shift within the major powers, but not the resulting direction of this movement (i.e., toward or away from a concentration of power). Since the direction of this movement is crucial to the analysis of this article, a MOVE-based indicator is inappropriate.

5. After the end of 1823, there was one other half-year period in which all the major powers were in the same cluster--the second half of 1840. Since ARIMA requires a complete time series, a bloc concentration score for this point was derived by interpolating between the two adjacent points.

It is a nonlinear estimation algorithm that tests for and then estimates two types of lagged effects on the current level of a time series variable:

- (1) The effects of the preceding levels of the variable. This is the autoregressive component.
- (2) The effects of random shocks to the preceding levels of the variable. This is the moving average component.

A more complete description of the ARIMA procedure is available in a variety of references; see, for example, Box and Jenkins (1976) or more accessible accounts in Pindyck and Rubinfeld (1976) and McCleary and Hays (1980).

The first pattern describes a relationship between adjacent values of BLOCCON; extreme values will be followed by less extreme values. In ARIMA terms, this implies that the only significant relationship in the series will be between the current level of the variable and the level immediately preceding it; this is an ARIMA (1, 0, 0) model. A further feature of this type of ARIMA model matches up well with the hypothesis. Since the hypothesis specifies a dampening effect, the value for the coefficient should be less than 1. An absolute value greater than 1.00 in the ARIMA estimation would indicate that the time series is not stationary and would have to be adjusted (Pindyck and Rubinfeld, 1976: 435). Note that temporal independence in successive values of bloc concentration would result in a failure to satisfactorily fit any ARIMA model to the data.

Not only will the fit of this particular ARIMA model be assessed, but other models will be estimated to ensure that alternative formulations not implied by hypothesis 1 provide a better fit to the data.

Using ARIMA modeling for the entire time period presents one problem: this technique requires a complete data series, and it was not possible to generate bloc concentration scores during the two World Wars. When using ARIMA for the entire period, I chose to remove the missing values and treat the series as if the first post-War observation immediately followed the last pre-War observation. This is not an ideal solution, but I believe it is a reasonable one.

The hypothesized patterns concerning the changes in BLOCCON from extreme levels will be examined using t-tests. This necessitates that extreme values of BLOCCON be identified. For both patterns, extreme levels will be defined as values greater than one standard deviation from

the mean. For the second pattern, values of BLOCCON at time t are dichotomized into very high observations (greater than one standard deviation above the mean) and all other levels. This variable is then used to group changes in BLOCCON from time t to time $t + 1$, and a t -test is run to determine if the mean value of the change in BLOCCON is different for the two groups. Support for the existence of a balance of power system is inferred if there is a significant difference between the means of the two groups and if the mean change from the very high level of BLOCCON is negative.

The third pattern is tested in a parallel fashion. Values of BLOCCON at time t are dichotomized into very low (smaller than one standard deviation below the mean) and all other levels. This dichotomy is then used to group the succeeding changes in BLOCCON, and a t -test is run. Support for the existence of a balance of power system is inferred if this hypothesis is disconfirmed; that is, if there is no significant difference in the mean change from either level of BLOCCON.⁶

The final pattern noted above was a shift in the variance of BLOCCON in the post-1919 era. This will be examined using an F -test for the equality of the variances. Support for the pattern will be inferred if the two variances are found to be unequal. Table 1 displays a brief description of each pattern and the statistical technique to be used to examine it.

RESULTS

Before the results of the statistical analysis are discussed, let me examine the plot of the bloc concentration values over time (Figure 1), and their descriptive statistics (Table 2).

The visual pattern in Figure 1 is consistent with the arguments advanced about the patterns of bloc concentration levels. BLOCCON shows the up and down pattern described in P1 and P4. Further, the gyrations of bloc concentration in the pre-World War I period are more pronounced than in the later years.

Probing a bit deeper, I note that the highest peaks of bloc concentration (1827-1830, 1859-1863, and 1904-1907) all occur in the earlier period and that all are the result of alliance activity among the

6. Although the distribution of BLOCCON is positively skewed during the 1824-1914 era, the equal number of extreme values (20 greater than 1 standard deviation above the mean, 21 greater than 1 standard deviation below the mean) leads me to believe that the t -test results will not be misleading. Further, I would argue that this type of distribution is implied by the theoretical framework.

TABLE 1
Anticipated Patterns of BLOCCON and Associated Statistical Test

<i>Pattern</i>	<i>Statistical Test</i>
1. 1824-1914: Adjacent BLOCCON Levels Related to One Another.	1. ARIMA (1,0,0) model.
2. 1816-1914: High Levels of BLOCCON followed by Changes Downward.	2. T-test.
3. 1814-1914: Low Levels of BLOCCON Not Followed by Any Systematic Change.	3. T-test.
4. 1824-1965: Adjacent BLOCCON Levels Related to One Another.	4. ARIMA (1,0,0) model.
5. 1816-1965: High Levels of BLOCCON Followed by Changes Downward.	5. T-test.
6. 1816-1965: Low Levels of BLOCCON Not Followed by Any Systematic Change.	6. T-test.
7. Decrease in Variance of BLOCCON from 1824-1914 Period to 1919-1965 Period.	7. F-test.

major powers.⁷ Both of these observations are also consistent with the expected patterns noted above. Table 2 provides additional confirmation of the difference in bloc concentration between the pre- and post-World War I eras. The standard deviation of BLOCCON is much smaller in the post-1919 period, particularly after World War II.

RESULTS: 1824-1914

With this preliminary discussion in mind, let me proceed with the fitting of the ARIMA (1, 0, 0) model to the earlier time period. The autocorrelation and partial autocorrelation functions (Tables 3 and 4) for the BLOCCON time series are strong evidence for an ARIMA (1, 0, 0) process—an autocorrelation function that trails off in a dampened exponential pattern from a peak at lag 1, and a partial autocorrelation

7. The first peak (1827-1830) was due to a British-French-Russian alliance in support of the Greek struggle for independence. This situation was finally resolved (after one civil war, a naval battle between the powers and Turkey, and a Russo-Turkish war) in 1830 with the signing of the London Protocol (Albrecht-Carrie, 1973: 43-48), and the alliance was dissolved. The second peak (1859-1863) began with a Franco-Russian alliance to ensure the latter's neutrality in the conflict for Italian Unification (Taylor, 1977: 104-106). The emergence of Italy at the end of 1860 produced a dip in concentration, but a rise occurred in the second half of 1861, when Britain joined France (and Spain) in an agreement to occupy Vera Cruz, Mexico. Britain withdrew from the agreement in 1862 (Albrecht-

TABLE 2
Descriptive Statistics for BLOCCON (Various Time Periods)

<i>Period</i>	<i>N</i>	<i>Mean</i>	<i>Standard Deviation</i>
1824-1965	265	.193	.119
1824-1914	183	.202	.133
1919-1965	82	.171	.073
1919-1940	42	.212	.053
1946-1965	40	.128	.067

function⁸ with only a single significant peak at the first lag (McCleary and Hays, 1980: 60-79). Table 5 displays the estimated equation for the ARIMA model.

Turning to Table 5, the size of the t-ratios and the nonsignificance of the Q statistic (a chi-square test for the randomness of the residuals) indicates that this simple model captures much of the fluctuation in the levels of BLOCCON. Overfitting was tried, adding several other terms (both autoregressive and moving average) to the model, but none of these more complicated variants showed any increased ability to account for the data series.

The results of the ARIMA modeling show that the bloc concentration level is dependent on its previous value. Further, the value of the coefficient for the previous level (.830) indicates, as hypothesized, that among European major powers during this time period, there was a tendency for extreme values of BLOCCON to dampen toward less excessive values.

The results of both t-tests for the earlier era (Table 6) are also consistent with the expected patterns of a balance of power system. Very high levels of BLOCCON are followed by downward changes, while

Carrie, 1973: 116-120). The last rise during this peak period occurred at the end of 1863, due to a short-term alliance between Prussia and Russia. This created a cluster of major powers that included those two nation states as well as France and Austria-Hungary. The Prussian-Russian pact was formed to put down the Polish insurrection of that year (Albrecht-Carrie, 1973: 11). At the conclusion of that episode, the bloc concentration level fell off dramatically. The final rise of BLOCCON occurred in 1904, when Britain moved from "splendid isolation" into a loose bloc with France and Russia. The tightening of this cluster in August 1907, due to an Anglo-Russian entente, led to an even balance between the two blocs of major powers (Britain, France, and Russia versus Germany, Austria-Hungary, and—for a time—Italy). This grouping persisted until the outbreak of World War I.

8. The partial autocorrelation function is a measure of the correlation between the value of the variable and a specific lag (i.e., BLOCCON and its lag at time $t-2$), controlled for the effect of all other lags.

Figure 1: Bloc Concentration Scores, 1824-1965

TABLE 3
ARIMA Results, 1824-1914
Estimated Autocorrelations

Lag	Autocorrelation	-1	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	1
1	0.82125												*****									
2	0.66952								.				*****									
3	0.51846								.				*****									
4	0.36950								.				*****									
5	0.24813								.				*****									
6	0.12438								.				**									
7	0.02334								.													
8	0.00653								.													
9	-0.00117								.													
10	0.00612								.													
11	-0.00172								.													
12	0.00659								.													
13	0.01799								.													
14	0.01574								.													
15	0.02836								.			*										
16	0.04036								.			*										
17	0.05348								.			*										
18	0.06323								.			*										
19	0.07131								.			*										
20	0.08674								.			**										
21	0.09059								.			**										
22	0.09475								.			**										
23	0.07742								.			**										
24	0.06217								.			*										

NOTE: Dots mark two standard errors.

levels that are not very high do not show the same change. Further, the difference between these two mean values is significant. As for the effects of very low values of bloc concentration, there is only a slight tendency for changes in BLOCCON to be positive after these values.

In sum, the empirical evidence presented above is consistent with the existence of a balance of power system operating among the European major powers from 1824 through 1914.

RESULTS: 1824-1965

Tables 7 and 8 display the results of the analysis when the entire period is used. As can be seen, they are very similiar to those for the

TABLE 4
ARIMA Results, 1824-1914
Estimated Partial Autocorrelations

<i>Lag</i>	<i>Partial Autocorrelation</i>	-1	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	1
1	0.82125										.		*****									
2	-0.01514										.		.									
3	-0.08378										..		.									
4	-0.09252										..		.									
5	-0.02201										.		.									
6	-0.09704										..		.									
7	-0.04085										.	*	.									
8	0.16814										.		***									
9	0.01517										.		.									
10	0.00585										.		.									
11	-0.06860										.	*	.									
12	0.03451										.		*	.								
13	-0.00703										.		.									
14	-0.03482										.	*	.									
15	0.07457										.		*	.								
16	0.03256										.		*	.								
17	0.01819										.		.									
18	-0.02294										.		.									
19	0.02853										.		*	.								
20	0.03511										.		*	.								
21	-0.02148										.		.									
22	0.02898										.		*	.								
23	-0.04085										.	*	.									
24	0.01217										.		.									

NOTE: Dots mark two standard errors.

TABLE 5
ARIMA Results, 1824-1914
Coefficient Estimates

<i>Variable</i>	<i>Estimate</i>	<i>T-Ratio</i>	<i>Significance</i>
Intercept	0.033	6.83	< .005
BLOCCONt - 1	0.830	19.63	< .005

NOTE: Standard error estimate = 0.075; Q Statistic = 12.8 with 22 df; prob. = .94; N = 182.

TABLE 6
T-Test Results, 1824-1914
Changes in BLOCCON by Extreme Levels of BLOCCON in Previous Half Year

<i>Previous Level of BLOCCON</i>	<i>N</i>	<i>Mean of DBLOCCON</i>	<i>Standard Deviation DBLOCCON</i>	<i>T-Ratio</i>	<i>Significance</i>
Very High	20	-.061	.142	3.84	.0002
Not Very High	160	.007	.063		
Very Low	21	.009	.026	-.58	.56
Not Very Low	159	-.001	.083		

NOTE: DBLOCCON = change in BLOCCON.

TABLE 7
ARIMA Results, 1824-1965
Coefficient Estimates

<i>Variable</i>	<i>Estimate</i>	<i>T-Ratio</i>	<i>Significance</i>
Intercept	0.033	8.87	< .005
BLOCCON _{t-1}	0.822	23.36	< .005

NOTE: Standard error estimate = 0.068; Q Statistic = 10.3 with 22 df; prob. = .98; N = 265.

pre-World War I period. The coefficients for the ARIMA model are virtually identical to those of the earlier period. The same is true of the t-test when BLOCCON values are dichotomized into very high and not very high. The one difference is the almost significant t-value for the entire period when BLOCCON levels are dichotomized into very low and not very low. This shift in finding is undoubtedly due to the fact that almost half of the extremely low values (17 out of 38) occur after World War I.

Finally, Table 9 displays the results of the F-test for equality of variances in the pre- and post-World War I era. The significant F-value supports the conjecture that the later period would feature less movement of bloc concentration, due to a low level of alliance flexibility.

TABLE 8
T-Test Results, 1824-1965
Changes in BLOCCON by Extreme Levels of BLOCCON in Previous Half Year

<i>Previous Level of BLOCCON</i>	<i>N</i>	<i>Mean of DBLOCCON</i>	<i>Standard Deviation DBLOCCON</i>	<i>T-Ratio</i>	<i>Significance</i>
Very High	22	-.048	.144	3.46	.0009
Not Very High	242	.003	.057		
Very Low	38	.016	.040	-1.60	.11
Not Very Low	224	-.004	.073		

NOTE: DBLOCCON = change in BLOCCON.

SUMMARY

Much of the literature in international relations discusses the concept of balance of power. There is much disagreement about the meaning of the term, about whether a balance of power system existed in the past, and, finally, even among those scholars who believe that a balance of power system did exist, about the empirical parameters that define it. This article began by restricting the meaning of the phrase "balance of power" to balance of power as system. Next, I argued that it is possible to isolate a key concept in the operation of such a system: bloc concentration.

Using this concept, predictions were made concerning the system-level pattern of bloc concentration resulting from the moves and countermoves of the individual major powers. A complicated index construction procedure was used to create a measure for bloc concentration among the major powers from 1824 through 1965. The predicted patterns were evaluated both for the European major powers during the 1824-1914 period and for all major powers for the 1919-1965 period. The results were, with one exception, as anticipated. They show support for the existence of a balance of power system from 1824 to 1914 and for the continuation of a major power system, operating with some restrictions but still generally according to the tenets of realism, for the remainder of the time period.

TABLE 9
F-test Results, 1824-1965
Comparison of Variance of BLOCCON Before and After World War I

<i>Period</i>	<i>N</i>	<i>Variance</i>	<i>F-Value</i>	<i>Significance</i>
1824-1914	183	.0177	3.31	.0001
1919-1965	82	.0053		

This is not the first attempt to bring quantitative techniques to bear on the question of the existence of a balance of power system; a number of previous efforts were noted above. Moreover, some of these have also found support for the existence of a balance of power system during the same period of time as this investigation. But few earlier efforts have examined the combined impact of alliances and national capabilities, particularly when one or both of these is used as a dependent variable. I believe that both of these features are important in judging whether a balance of power system was in operation and in evaluating the collective behavior of the major powers even in the absence of a balance of power system. I would hope that others would follow up on the research presented in this article concerning the balance of power. Such a venerable concept deserves continued close attention, not only for what it can tell us about the past, but also for what it may reveal about the future.

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